DOCUMENT RESUME

ED 035 178 EF 001 336

TITLE	New Buildings with Fallout Protection.
INSTITUTION	Office of Civil Defense (DOD), Washington, D.C.
PUB DATE	Jan 65
NOTE	106p.
AVAILABLE FROM	Office of Civil Defense, Department of Defense, Washington, D.C.
EDRS PRICE	EDRS Price MF-$0.50 HC-$5.40
DESCRIPTORS	Architecture, *Building Design, *Fallout Shelters, Safety

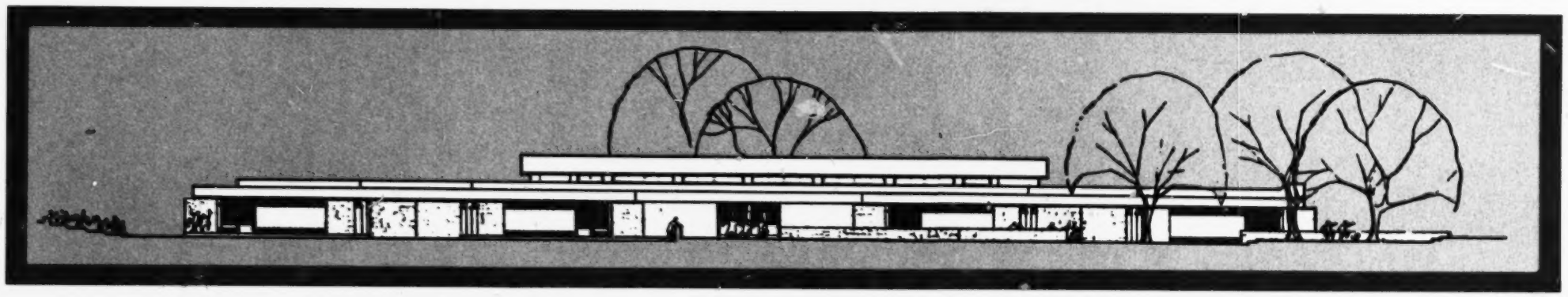
ABSTRACT

Fallout protection can be built into a building with little or no additional expense, using areas that are in continuous use in the normal functioning of the building. A general discussion of principles of shelter design is given along with photographs, descriptions, drawings, and cost analysis for a large number of recently constructed buildings of all types incorporating such fallout protection. (JT)

ED035178

TR 27—January 1965

NEW BUILDINGS WITH FALLOUT PROTECTION



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"AN EFFECTIVE CIVIL DEFENSE PROGRAM is an important element of our total defense effort.
It aims at the achievement of a nationwide fallout shelter system."

President of the United States

"Civil Defense is an integral and essential part of our overall defense posture. I believe it is clear from my discussions of the Strategic Retaliatory and Continental Air and Missile Defense Forces that a well planned and executed nation-wide civil defense program centered around fallout shelters could contribute much more, dollar for dollar, to the savings of lives in the event of a nuclear attack upon the United States than any further increases in either of those two programs."

ROBERT S. MCNAMARA,
Secretary of Defense.

Preface

The objective of the National Fallout Shelter program is to provide shelter space for every American. Millions of shelter spaces have already been located in existing buildings, but not enough to satisfy requirements. Additional shelter spaces are necessary. The buildings depicted in this report illustrate what is now being accomplished to help alleviate this deficit.

Every building is a shelter from weather extremes and from outside distractions. And every building serves a purpose: a home, a school, an industrial plant—the list is endless.

The new buildings described in this report meet these needs, and one more. They have been designed and built to provide protection from radioactive fallout in the event of nuclear attack.

This additional function has been met in each case without sacrificing the day-to-day usefulness of the building or its esthetic qualities, and with little or no increase in construction costs. Some of the structures depicted may have been constructed with shelter inherent in the initial design, however, architects and engineers with their knowledge of radiation shielding have enhanced the shelter potential by increasing capacity and protection provided.

Special knowledge makes this possible—knowledge of the nature of radioactive fallout and how to design structures to provide shielding against it. Spreading this knowledge to professionally trained architects and engineers is a major aspect of the nationwide fallout shelter program.

The first significant step toward the goal of professional knowledge and skill in fallout shelter design came in late 1961 when architects and engineers enrolled in special Fallout Shelter Analysis Courses in preparation for the National Fallout Shelter Survey. These courses are still offered today, and more than 7,000 architects and engineers have been certified as Fallout Shelter Analysts by the Department of Defense.

The immediate objective of this professional development program was to survey and locate potential public fallout shelter space in existing structures—a type of post-design analysis. But the program also provided, and provides today, the orientation that architects and engineers must have if fallout protection is to be considered at the critical point in the creation of a building—the design stage.

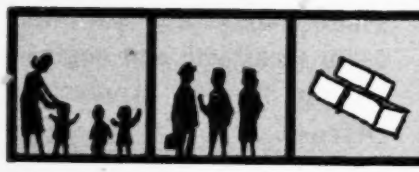
To demonstrate the feasibility of designing low-cost fallout shelter space in new buildings and to develop ideas on how this can be done, the Office of Civil Defense sponsored a National School Fallout Shelter Design Competition in 1962 with the cooperation of the American Institute of Architects. This was followed by a similar competition on the design of fallout shelter space in shopping centers, and by an industrial shelter design conference at Rice University.

The designs that grew out of all these activities supported the concept that fallout shelter can be incorporated in new buildings without adversely affecting the cost, the appearance, or the functional use of the buildings.

But these were hypothetical designs—theory.

In this report, *New Buildings With Fallout Protection*, the theory becomes fact.

The report contains descriptions, photographs, drawings, and cost analyses of 34 new structures with built-in fallout protection—buildings designed for and constructed in widely separated communities throughout the United States.



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Schools

William Floyd Junior-Senior High School

Location: Shirley, Long Island, N.Y.
Owner: Union Free School District No. 32
Architect: Dobiecki, Beattie, and Colyer.
Brentwood, Long Island, N.Y.
Consulting Engineer:
Seelye, Stevenson, Value, and Knecht,
New York, N.Y.
Shelter Analyst:
Ernest M. Swanton,
Brentwood, Long Island, N.Y.

Project Cost: $3,719,000

Gross Area: 183,082 sq. ft.

Cost per sq. ft.: $20.42

Gross Shelter Area: 22,566 sq. ft. (17,614 sq. ft. net area)

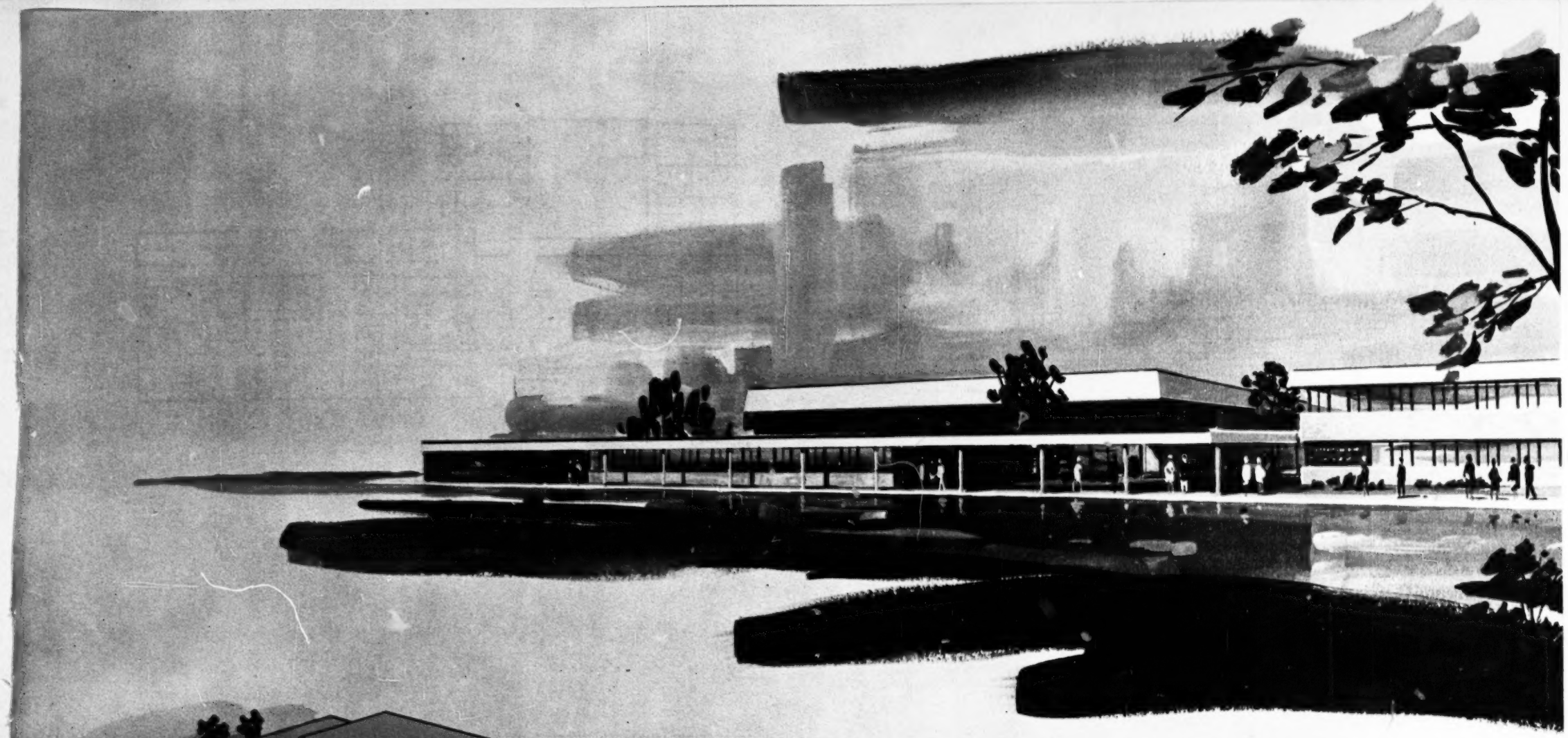
Shelter Cost:
General Construction: $5,000
Additional Equipment (ventilation, electrical, etc.): $36,000

Shelter General Construction Cost per sq. ft. of School Area: $0.03

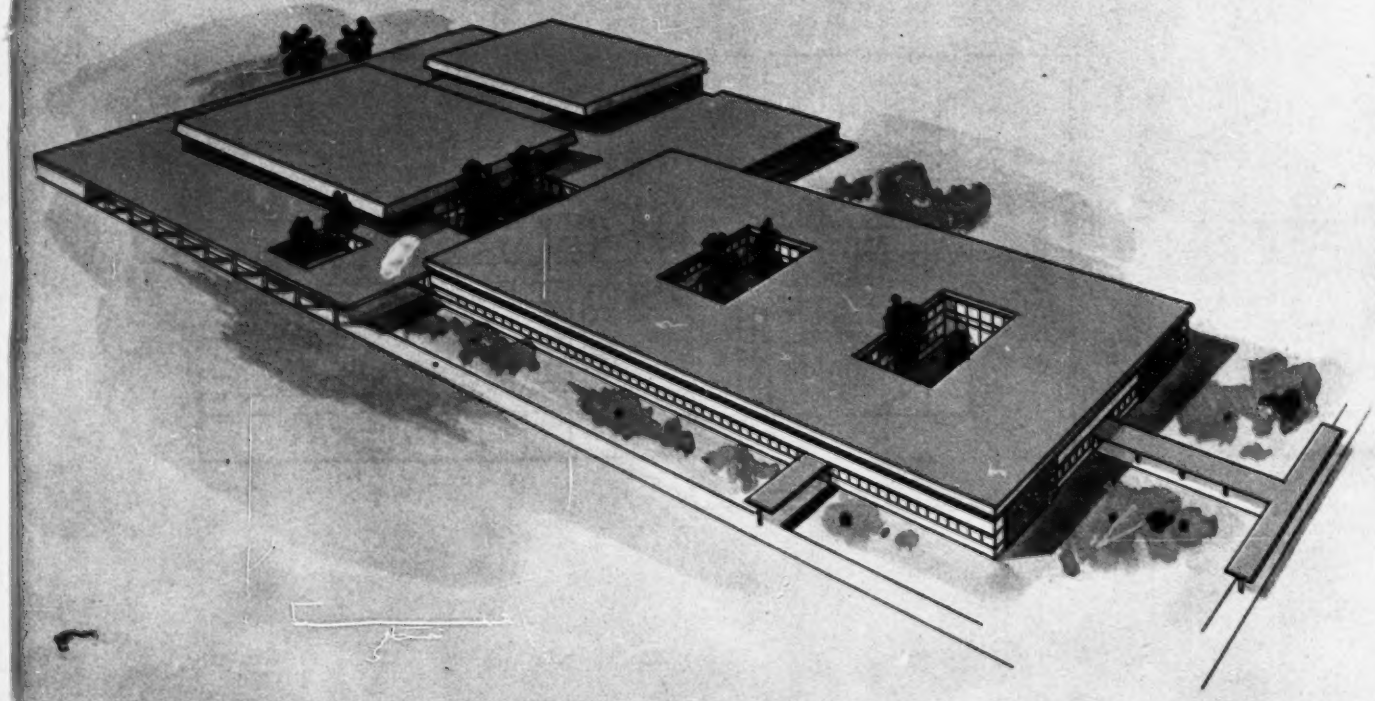
Because of the proximity to the Brookhaven National Laboratory (principal east coast Atomic Energy Commission Testing Facility), members of the School Board and townspeople were familiar with the dangers of radiation and were acutely aware of the lack of shelter facilities within the entire school district. In setting up the school building program the architect discussed incorporation of dual-use shelter space within the school and the School Board was enthusiatic. Emphasis on the dual-use aspect of the shelter space within the school facility was instrumental in the approval of the bond referendum by the taxpayers.

The school is essentially a two-story aboveground structure with a belowground basement which contains the cafeteria, kitchen, general food and building and ground storage areas. Shelter is located in the basement area. Concrete was added to the floor of the shop and industrial arts wing to provide the overhead protection to the general food and ground storage areas. By placing the cafeteria beneath the sloping stepped concrete floor of the auditorium area, the architect was able to utilize existing structural components to provide additional shelter spaces.

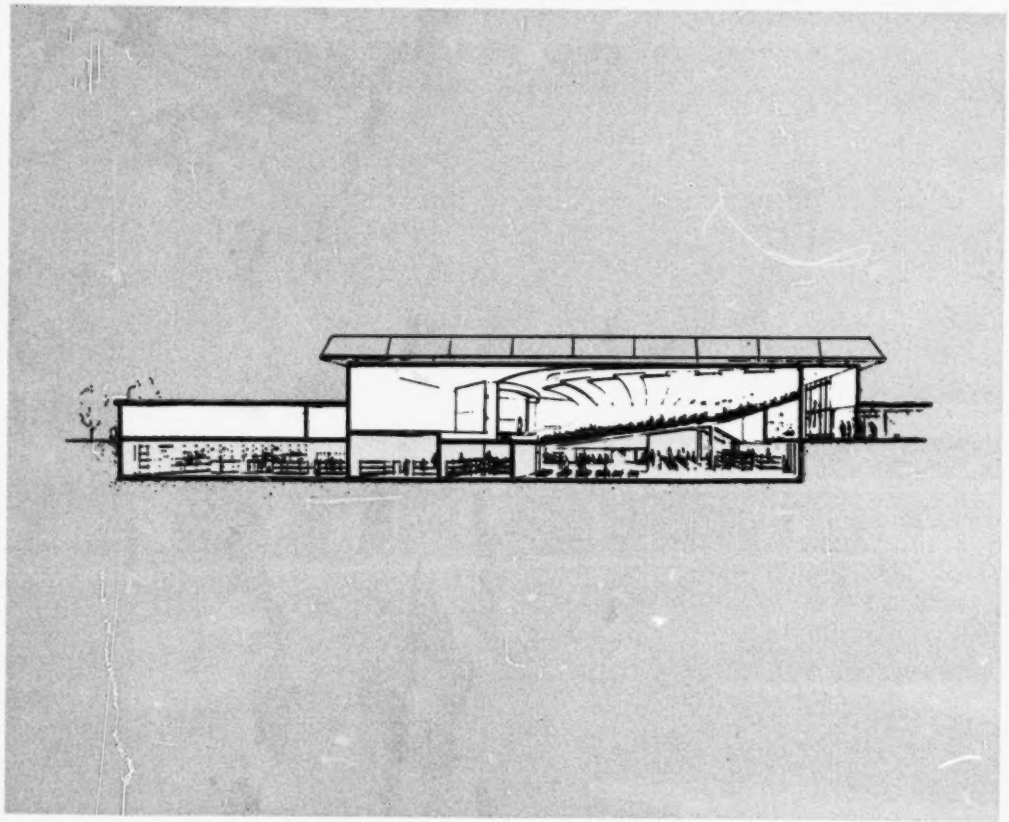
The school has a capacity of 1,550 and in an emergency can shelter 1,761 persons. The shelter area has a protection factor of more than 100.



Front Entrance



Aerial View



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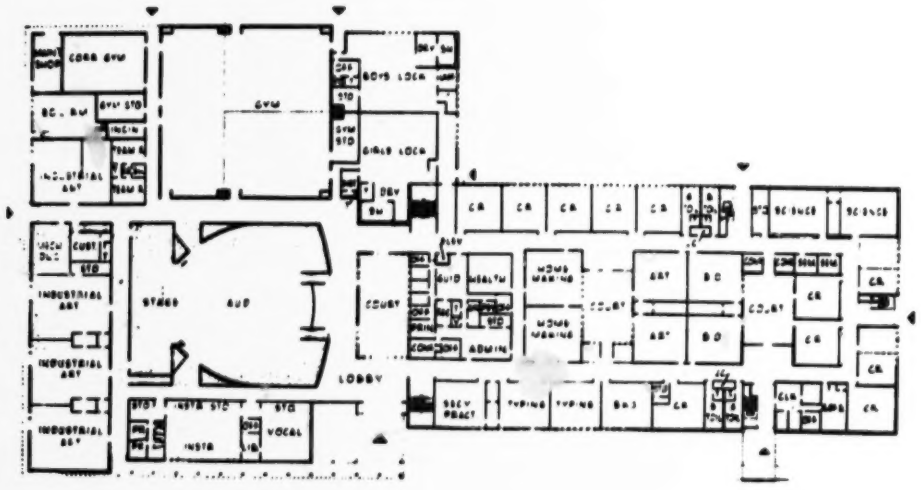
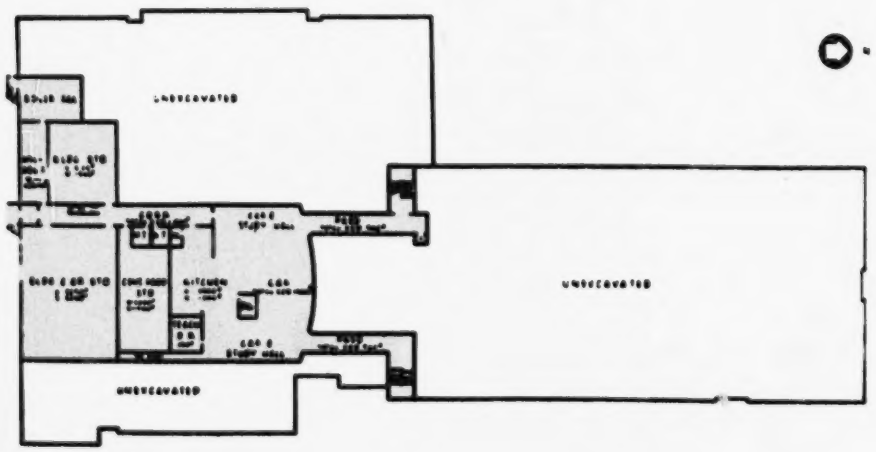
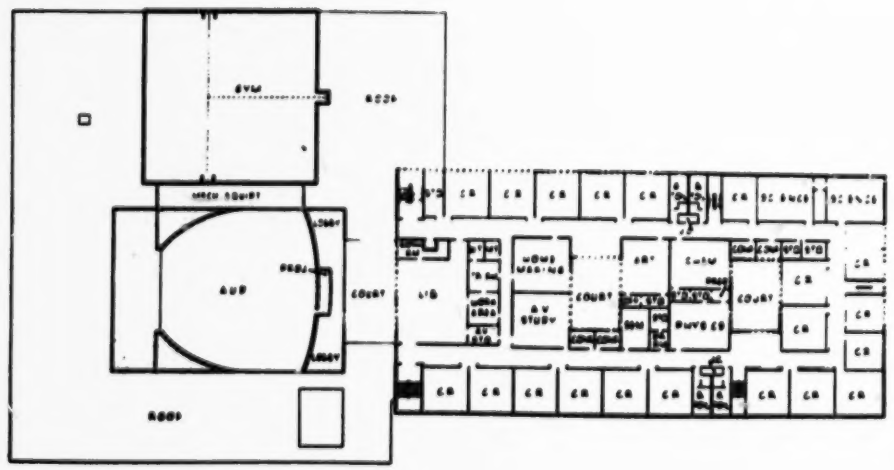
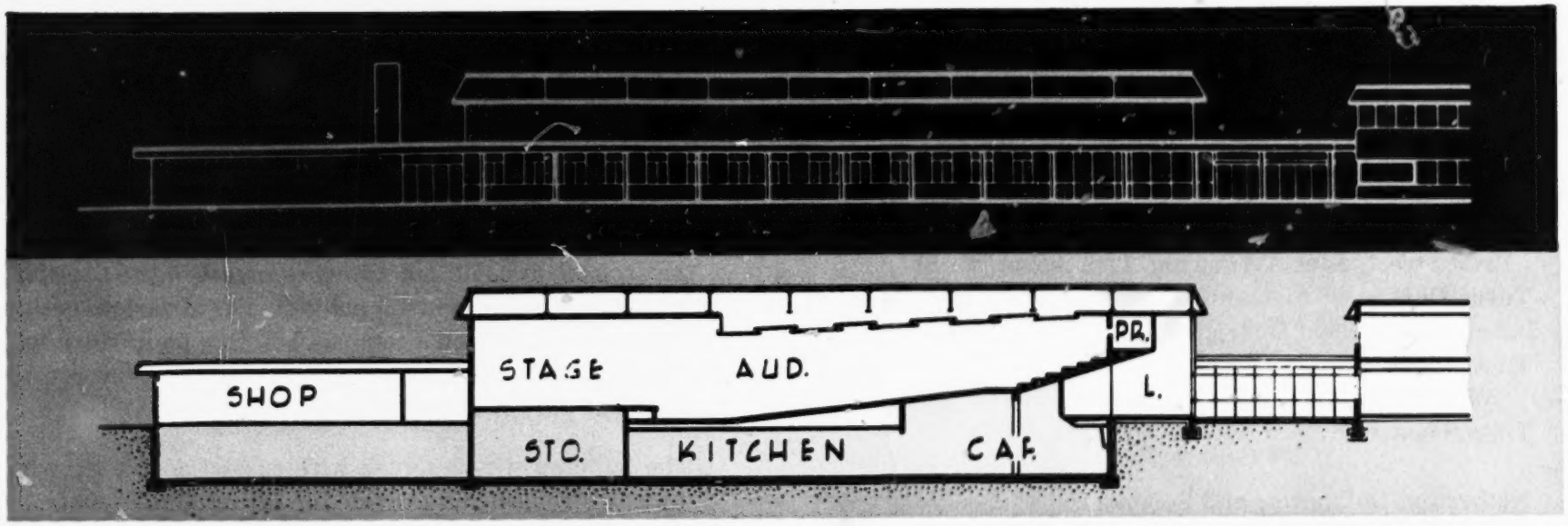
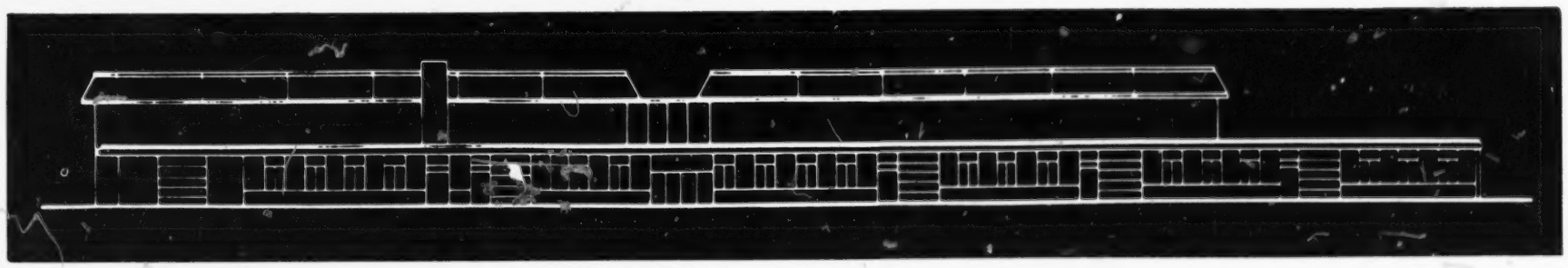


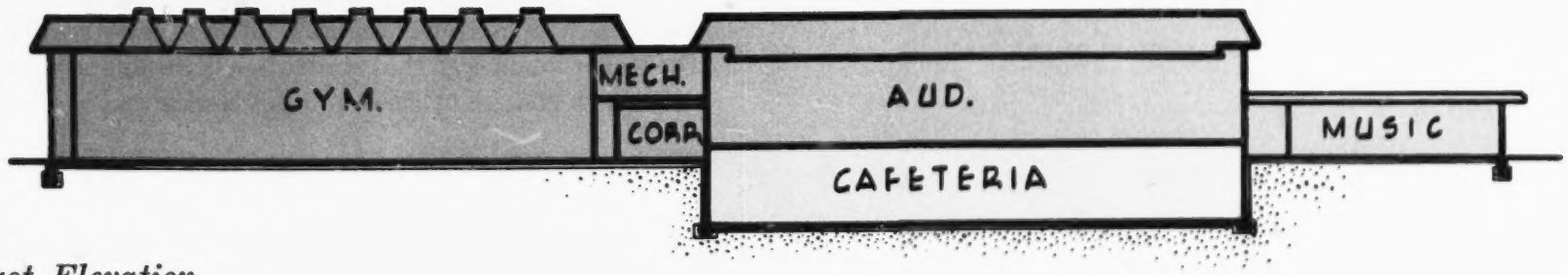
Floor Plans











East Elevation
Longitudinal Section
South Elevation
Cross Section

Schools

East Central High School

Location: 121st Street, East Avenue and 11th Street, Tulsa, Okla.

Owner: Independent School District No. 1, Tulsa County, Okla.

Architect: William Henry Ryan, AIA, Tulsa, Okla.

Engineer:
Netherton, Dollmeyer, and Solnok, CEC, Tulsa, Okla.

Shelter Analysts:
William Henry Ryan, AIA
Albert C. Solnok

Project Cost: $2,752,700 (exclusive of kitchen equipment, partitions, and stage equipment)

Gross Area: 203,798 sq. ft. (AIA method of calculation)
186,400 sq. ft. usable area

Cost per sq. ft.: $13.51 (based on A1A method of calculation)

Shelter Area: 54,689 sq. ft.

Shelter Cost: None—inherent in basic design

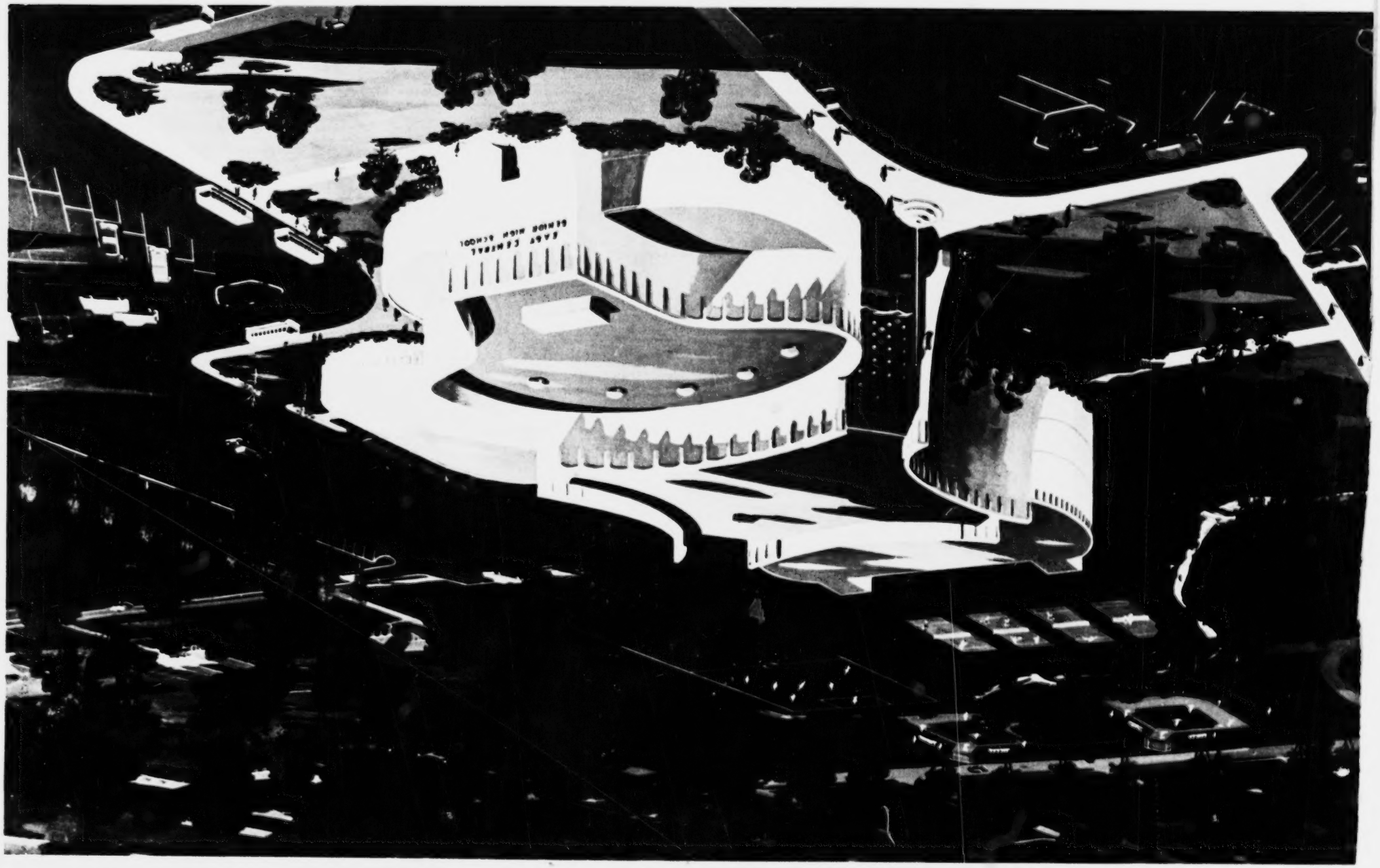
Construction Started: July 1964

The requirements for the East Central High School were to design a building containing 50 teaching posts capable of rapidly expanding to 90 teaching posts in the future. With the knowledge that the client could not afford to invest in the additional cost of shelter space, the architect made studies of various design schemes with the emphasis on a compact building plan which would result in lower square footage and site usage and incorporate shelter spaces as part of the inherent design.

The building was designed with curved double exterior walls to develop strength and provide for better climate control and sound control (it is near the Tulsa International Airport) with the walls to be used as mechanical and electrical chase areas. It consists of all-masonry construction with structural steel frames above ground-floor level and concrete frame on ground floor level. The core unit which contains the classroom areas, kitchen, cafeteria, offices, lobby and locker lounges is five floors high, with the ground floor partially belowground on a sloping site.

The building is air conditioned and all-electric, including the kitchen. It is virtually windowless; windows are located only over the four major entrances. The windows are positioned in the locker lounges so that students will be able to view the exterior with each change of class and not be distracted while in class.

Shelter areas are located in the ground-floor core (23,280 sq. ft.), ground-floor physical education wing (13,889 sq. ft.), and the second-floor core (17,420 sq. ft.). Due to the overhead protection provided the ground floor by the 8-inch reinforced concrete floor slab, and four other 2½-inch-thick floor slabs, a protection factor of 1,000 is available in the ground-floor area.



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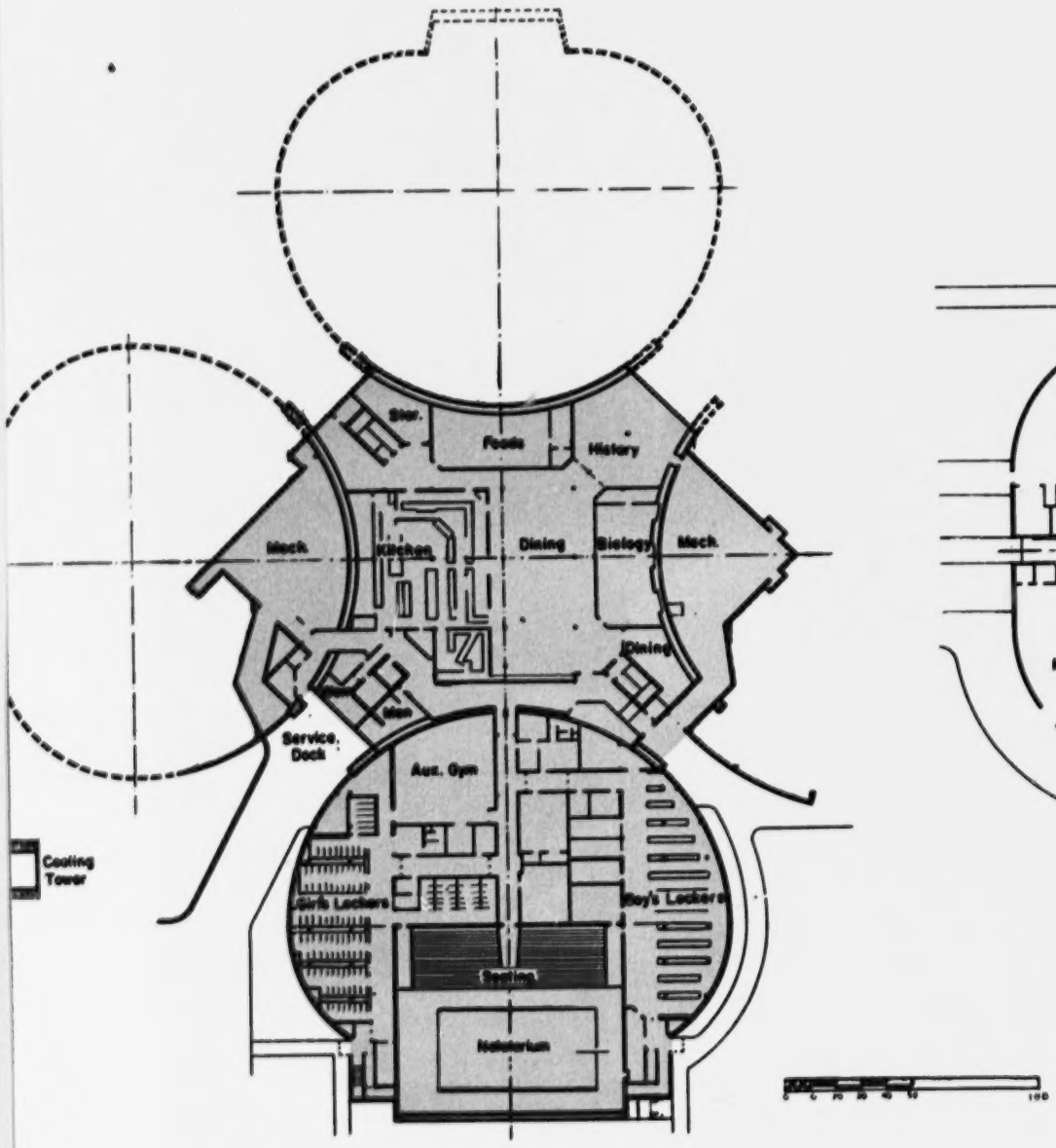
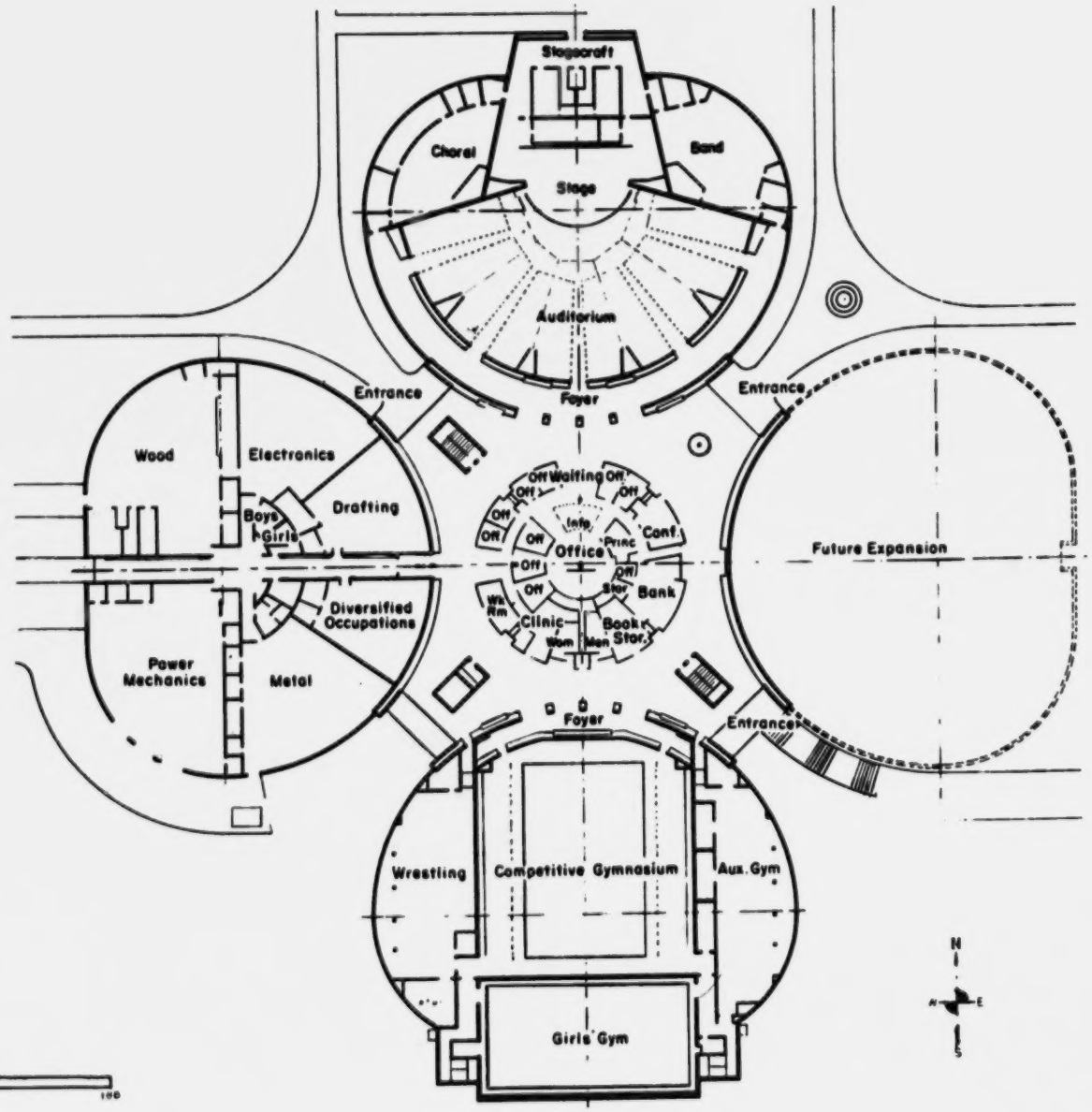
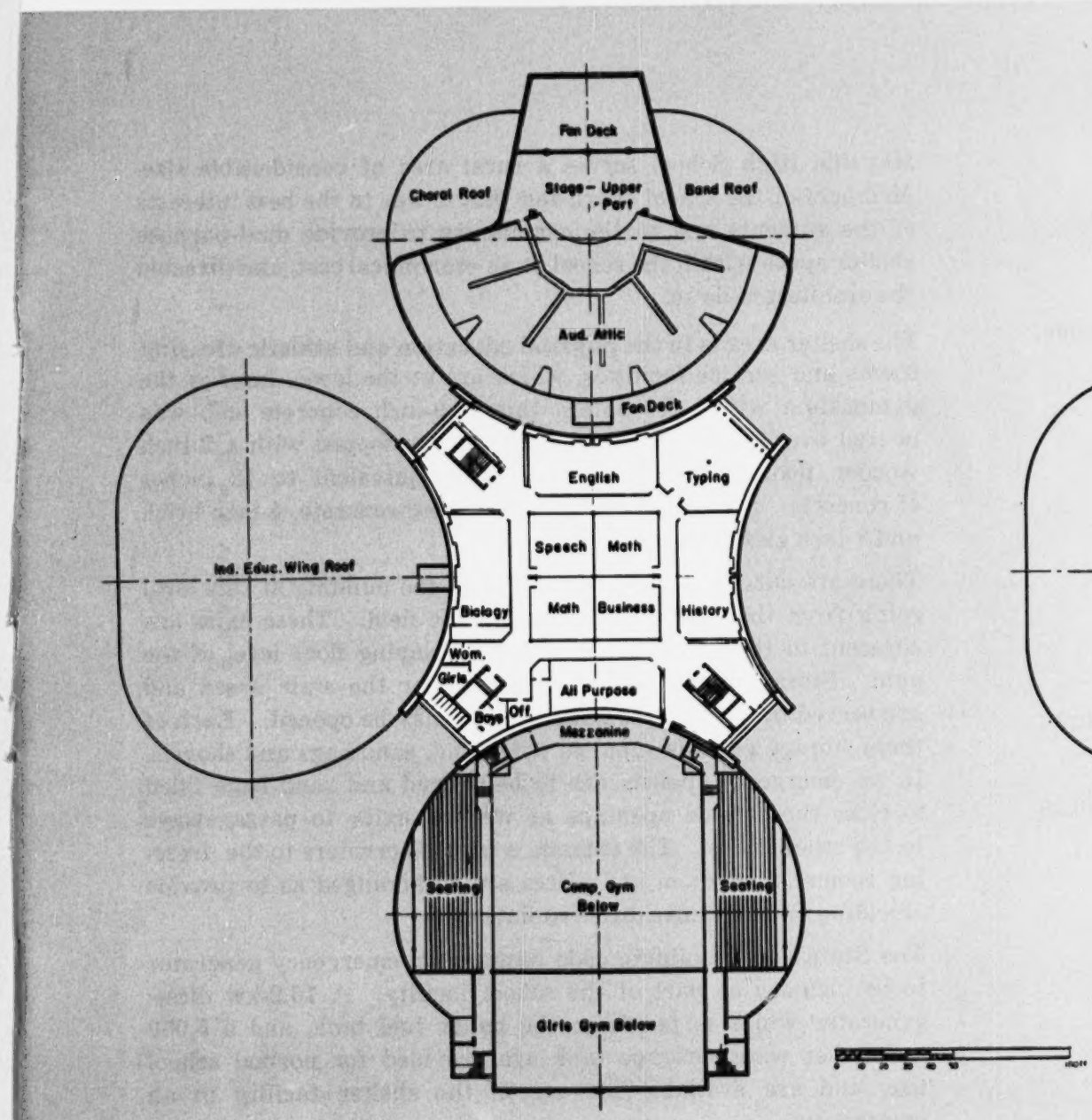


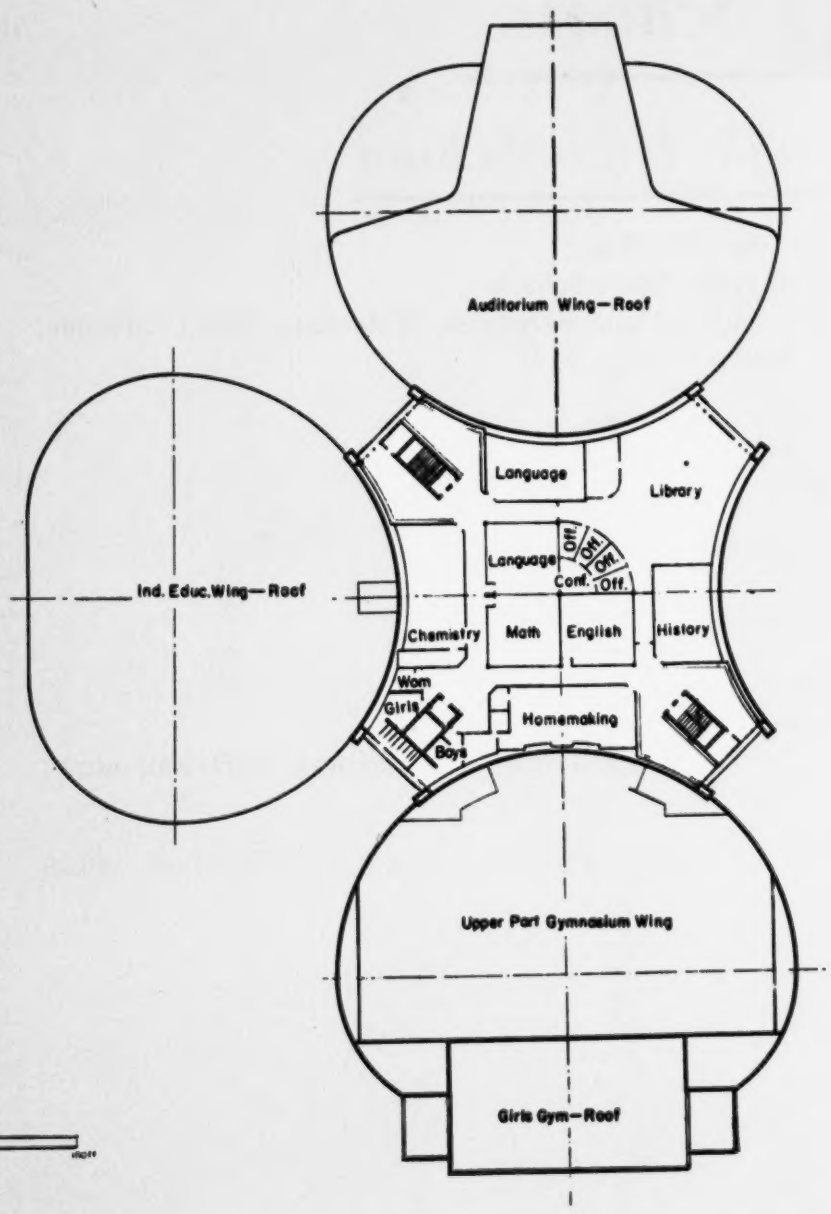
Ground Floor Plan



Main Floor Plan



Second Floor Plan



Third Floor Plan

Schools

Mayville High School

Location: Mayville, Wis.
Owner: Mayville Public Schools
Architect: Durrant and Bergquist, Watertown, Wis.; Dubuque, Iowa

Project Cost: $1,464,800

Gross Area: 111,686 sq. ft.

Cost per sq. ft.: $13.10

Shelter Area: 7,600 sq. ft.

Shelter Cost:

General construction: $14,000
Additional Equipment (mechanical, electrical, etc.): $4,000

Shelter General Construction Cost per sq. ft. of School Area: $0.13

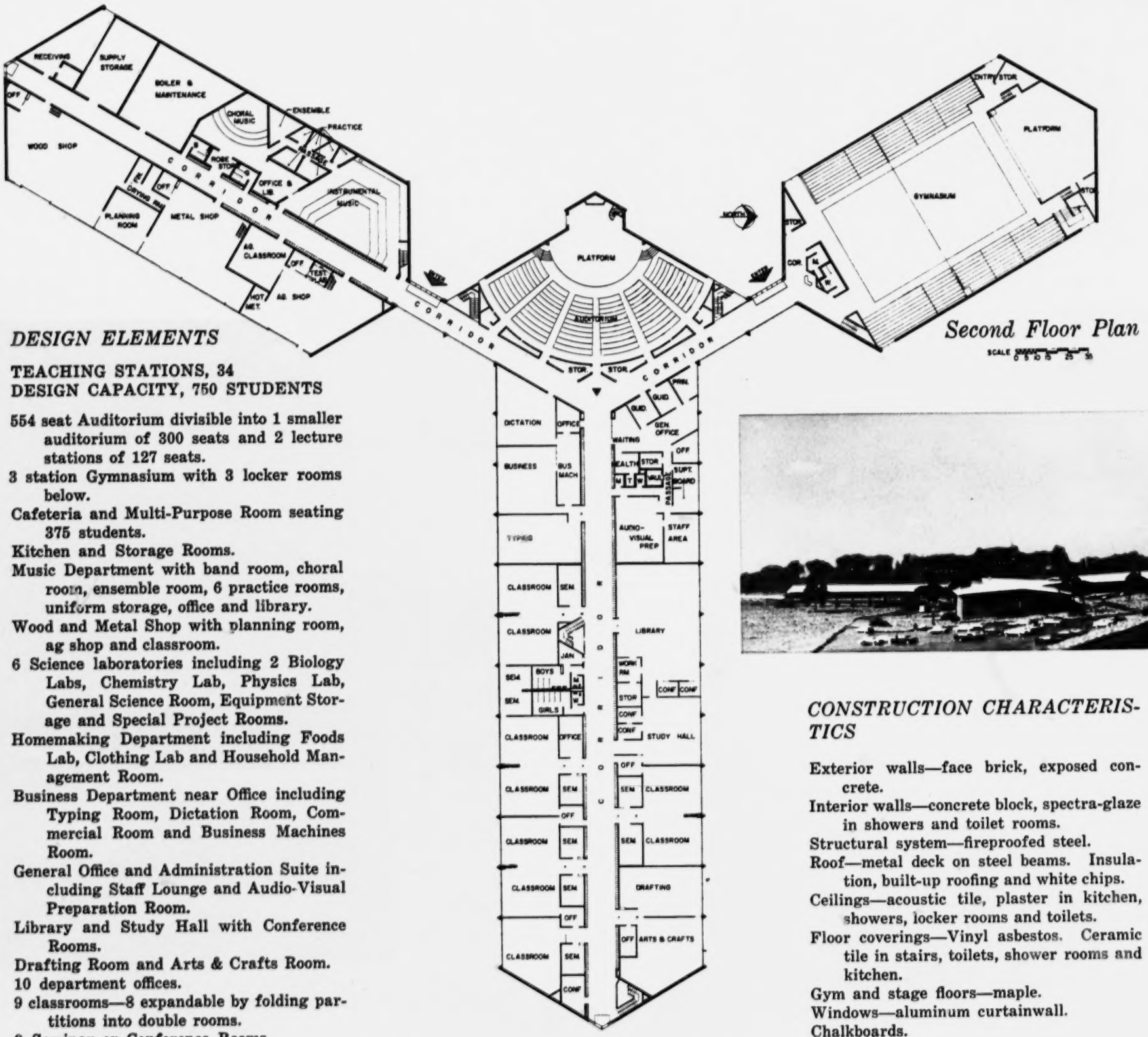
Mayville High School serves a rural area of considerable size. Members of the school board felt that it was to the best interests of the students and to the community to provide dual-purpose shelter space within the school at an economical cost, and directed the architect to do so.

The shelter area is in the physical education and athletic dressing rooms and service facilities, which are at the lower level of the gymnasium wing. To obtain this, a 9-inch concrete slab was poured over 2-inch concrete tees. This is topped with a 3-inch wooden floor thus creating a ceiling equivalent to 12 inches of concrete. Side walls are 12-inch poured concrete, 4-inch brick and 2-inch glazed block.

There are outside exists at each end of the building at this level going from the corridors to the athletic field. These exits are adjacent to the stairs going from the playing floor level of the gym. Storage areas are developed under the stair areas and are served by wall access panels which may be opened. Each of these storage areas is supplied with sand, sand bags and shovels. In an emergency, panels are to be opened and sand bags filled to close the outside openings as well as exits to passageways to the other areas. The entrances off the corridors to the dressing rooms, team room and offices are so arranged as to provide shielding and minimize direct radiation.

The State school building code requires an emergency generator to be included as part of the school facility. A 16.2-kw diesel generator which is fed from the boiler fuel tank, and a 5,000 gallon hot water storage tank are provided for normal school use, and are available for use in the shelter facility in an emergency.

School population is 560; shelter capacity is 760.



Second Floor Plan

SCALE 0 5 10 15 25 50

DESIGN ELEMENTS

TEACHING STATIONS, 34
DESIGN CAPACITY, 750 STUDENTS

554 seat Auditorium divisible into 1 smaller auditorium of 300 seats and 2 lecture stations of 127 seats.

3 station Gymnasium with 3 locker rooms below.

Cafeteria and Multi-Purpose Room seating 375 students.

Kitchen and Storage Rooms.

Music Department with band room, choral room, ensemble room, 6 practice rooms, uniform storage, office and library.

Wood and Metal Shop with planning room, ag shop and classroom.

6 Science laboratories including 2 Biology Labs, Chemistry Lab, Physics Lab, General Science Room, Equipment Storage and Special Project Rooms.

Homemaking Department including Foods Lab, Clothing Lab and Household Management Room.

Business Department near Office including Typing Room, Dictation Room, Commercial Room and Business Machines Room.

General Office and Administration Suite including Staff Lounge and Audio-Visual Preparation Room.

Library and Study Hall with Conference Rooms.

Drafting Room and Arts & Crafts Room.

10 department offices.

9 classrooms—8 expandable by folding partitions into double rooms.

9 Seminar or Conference Rooms.

CONSTRUCTION CHARACTERISTICS

Exterior walls—face brick, exposed concrete.

Interior walls—concrete block, spectra-glaze in showers and toilet rooms.

Structural system—fireproofed steel.

Roof—metal deck on steel beams. Insulation, built-up roofing and white chips.

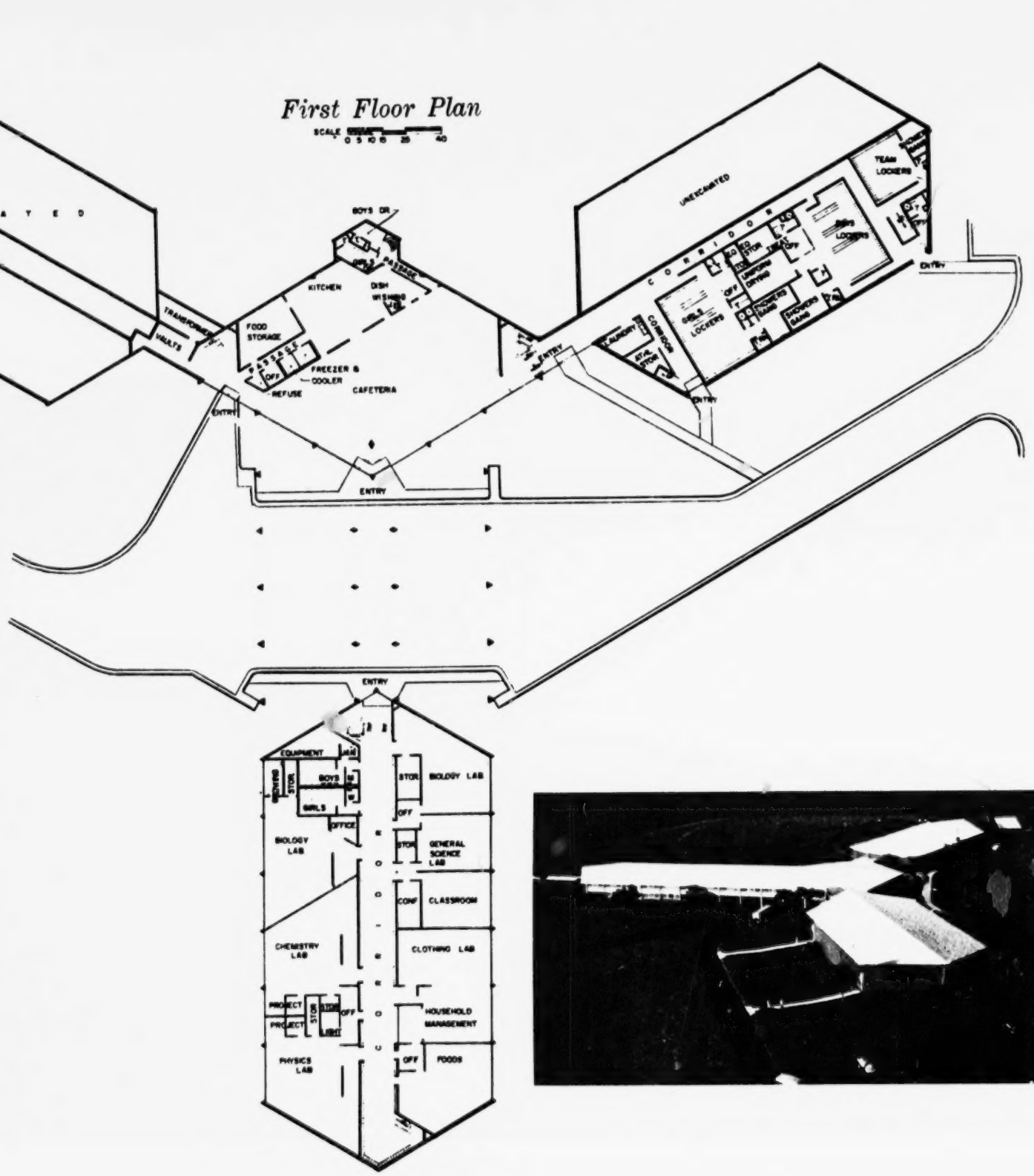
Ceilings—acoustic tile, plaster in kitchen, showers, locker rooms and toilets.

Floor coverings—Vinyl asbestos. Ceramic tile in stairs, toilets, shower rooms and kitchen.

Gym and stage floors—maple.

Windows—aluminum curtainwall.

Chalkboards.

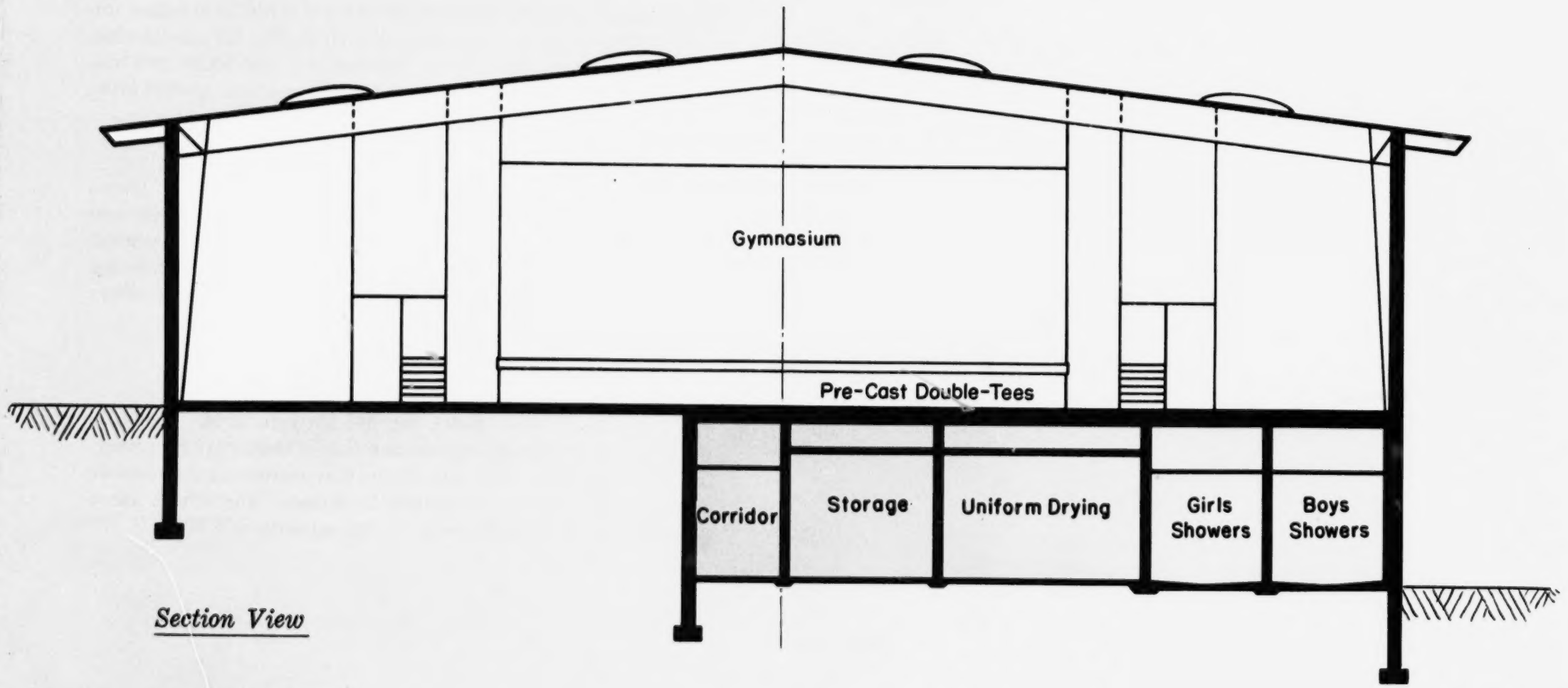


COST ANALYSIS

General	$1,100,400
Heating & Ventilating	167,416
Plumbing	77,200
Electrical	119,784
Total Construction Contracts	1,464,800
Kitchen	28,442
Laboratory and Arts & Crafts and Homemaking	45,547
Auditorium Stage Equipment	9,935
Auditorium Seating	14,720
Bleachers & Backstops	13,385
Auditorium Folding Part	23,097
Total Contract Price	1,599,926

GENERAL

Number of stories—Combination 1 and 2-story—No basement.
Area 111,686 sq. ft.
Cubage 1,618,464 cu. ft.
*Cost per square foot $13.10
*Cost per cubic foot .905
*Remarks: 1. Square foot cost and cubic foot cost are calculated only on the total of General, Heating and Ventilating, Plumbing and Electrical Work Contracts.
2. General Work contract includes extensive grading, drives, curbs and gutters, sidewalks and parking areas.



Section View

Schools

United High School

Location: Laredo, Tex.
Owner: United Consolidated Independent School District, Laredo, Tex.
Architect: Wyatt C. Hedrick & Associates, Houston, Tex.

Total Cost: $704,000

Gross Area: 68,000 sq. ft.

Cost per sq. ft.: $10.35

Shelter Area: 29,000 sq. ft.

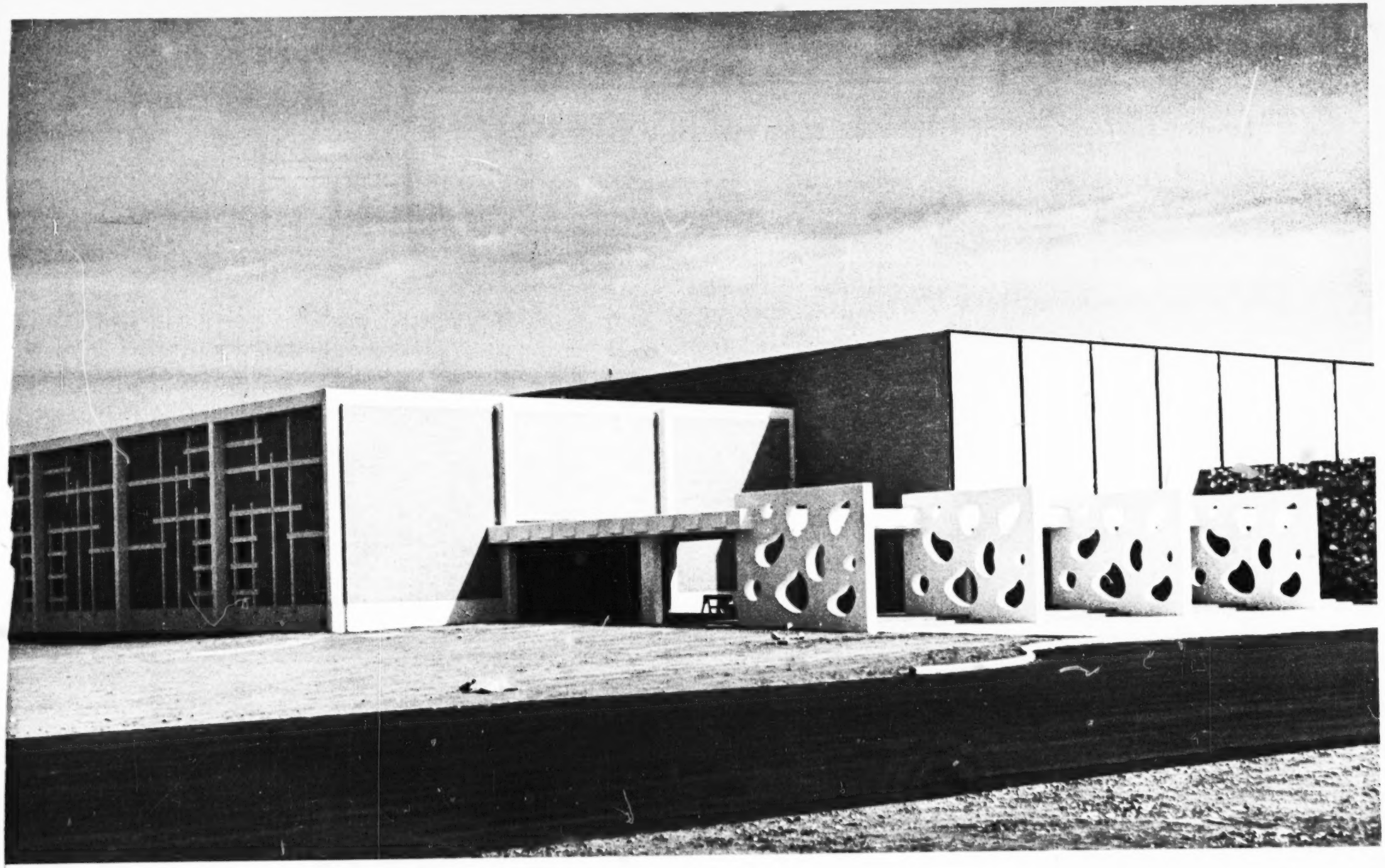
Shelter Cost:
General construction: $20,520
Additional Equipment (merchanical, electrical, etc.): $32,346

Shelter General Construction Cost per sq. ft. of School Area: $0.30

Plans and specifications for the construction of a conventionally designed school had been completed and presented by the architect to the School Board for approval. A member of the Board suggested cost studies be made for providing desired fallout protection. Although this necessitated redesign, cost estimates on the new concept indicated the desired features could be obtained for little increase in cost. The new design (including air conditioning and fallout shelter space) was obtained at a cost which was less than conventional construction of similar structures in that area.

The high school is a basement and ground-floor structure. Classrooms, cafeteria, science rooms, library, administrative and faculty offices, and mechanical rooms are located in the basement. The auditorium, gymnasium, general toilet, shower and dressing rooms, vocational training shops, and general supervisory offices are located on the ground floor.

The high school was opened for use early in 1964. Virtually the entire basement area serves as a fallout shelter with a protection factor of 100. This was obtained by increasing the concrete overhead floor slab to a 14-inch thickness. The school has a student capacity of 540 and a shelter capacity of 2,000.



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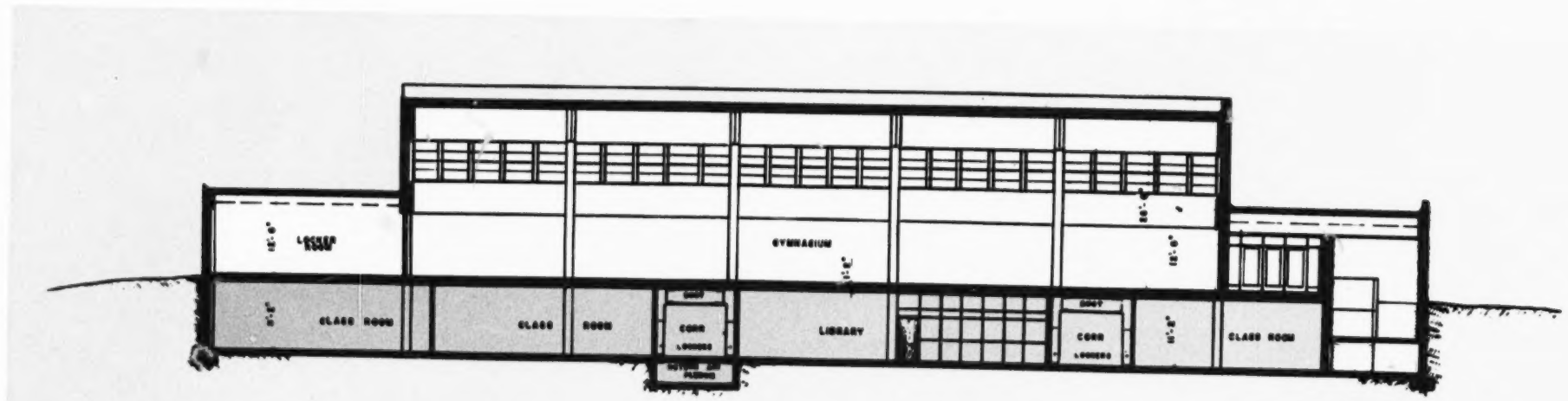

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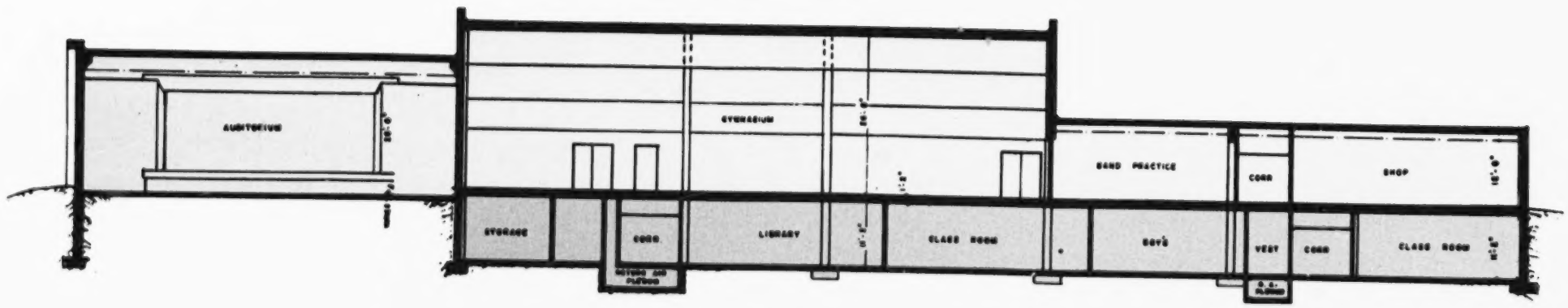

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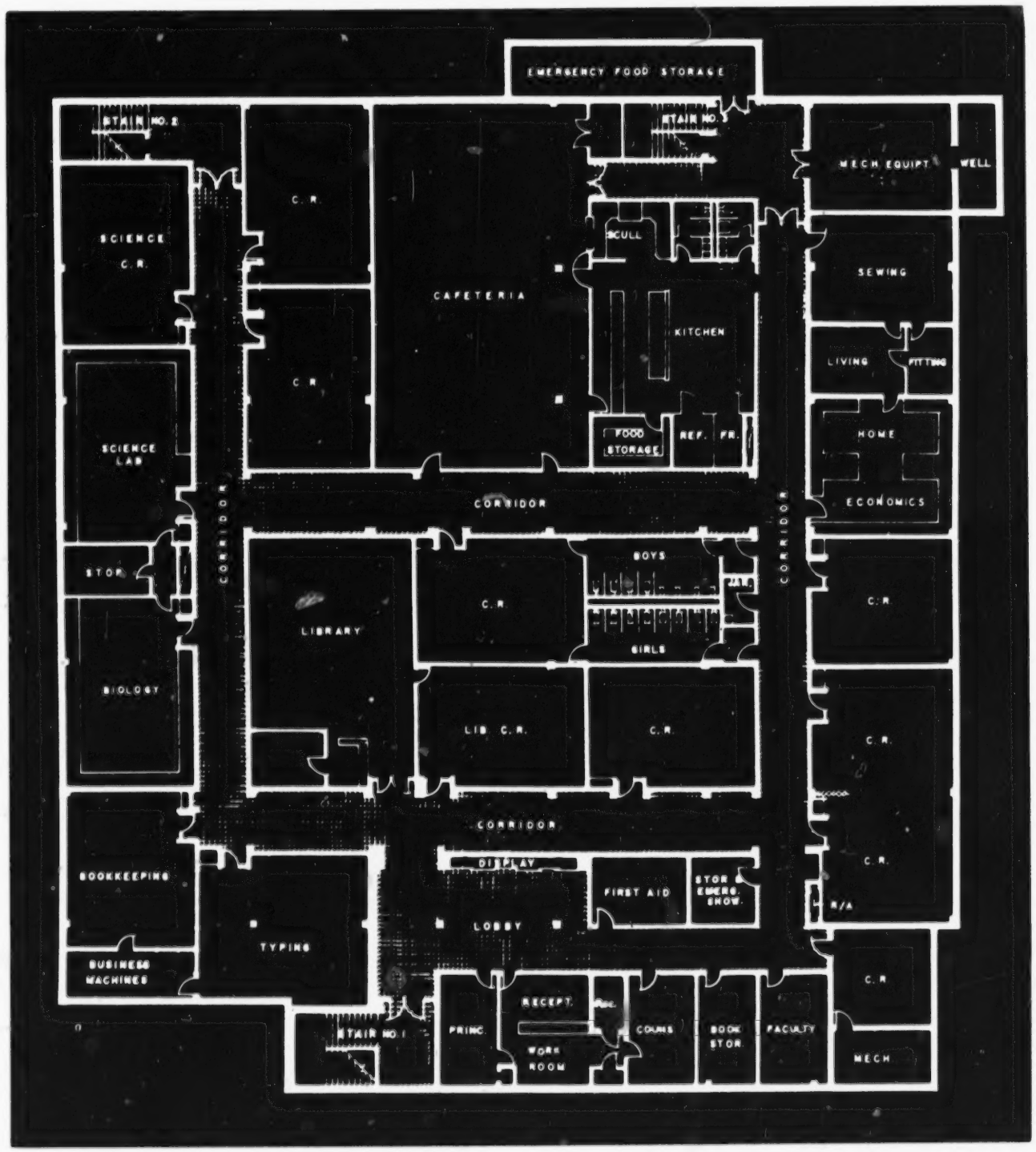


Below Grade Floor Plan

SCALE 1/16" = 1'-0"

GRAPHIC SCALE 0' 16' 32' 48'

Schools

Junior High School 201

Mechanical Engineer:
Brown & Pomerantz,
New York City

Shelter Analyst:
Morris Liebeskind,
New York City

Total Cost: $4,812,145

Gross Area: 190,396 sq. ft.

Cost per sq. ft.: $25.27

Shelter Area: Approximately 70,000 sq. ft.

Shelter Cost: None—inherent in basic design

Location: Manhattan, N.Y.

Owner: New York City Board of Education

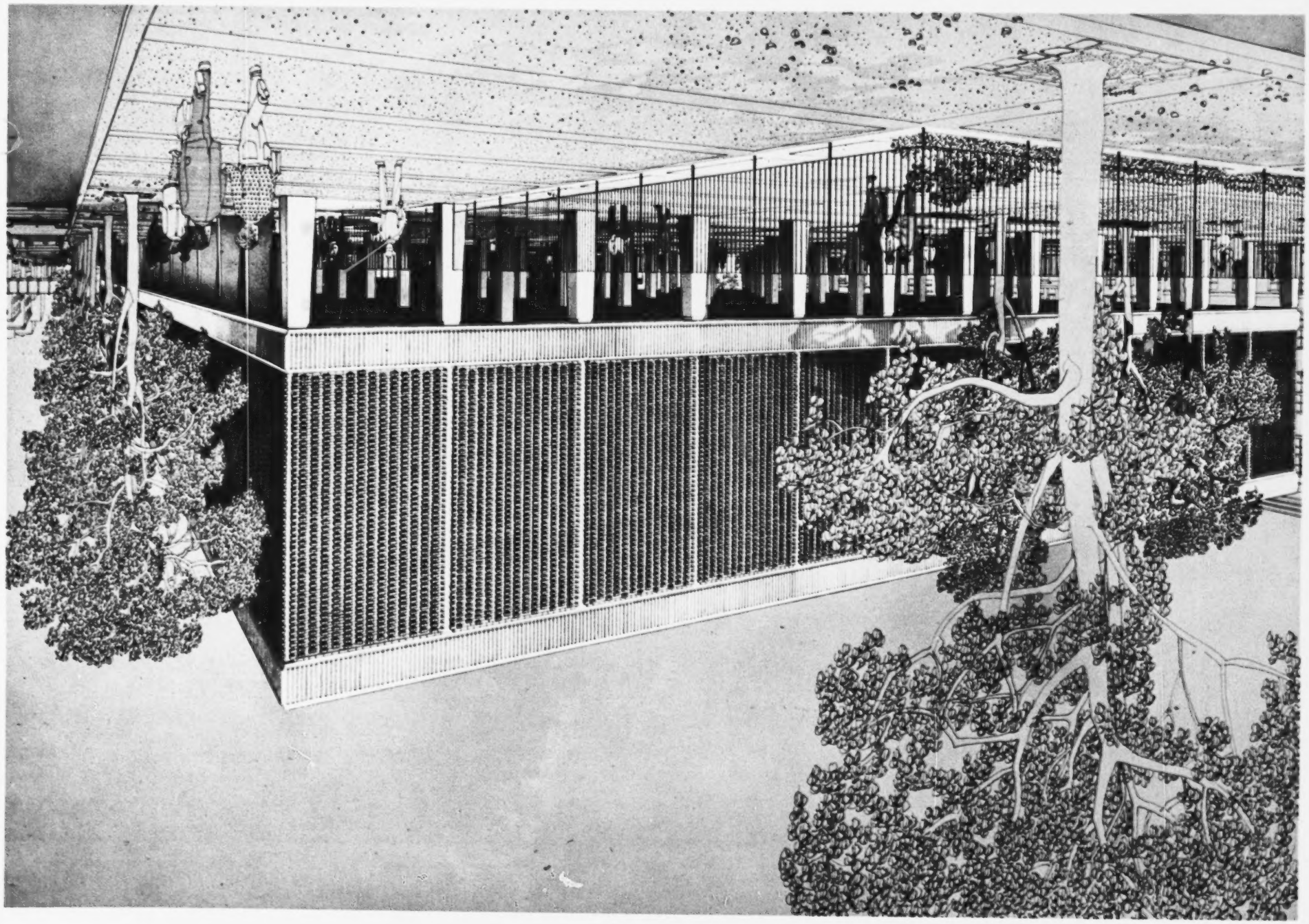
Architect: Curtis & Davis,
New York City

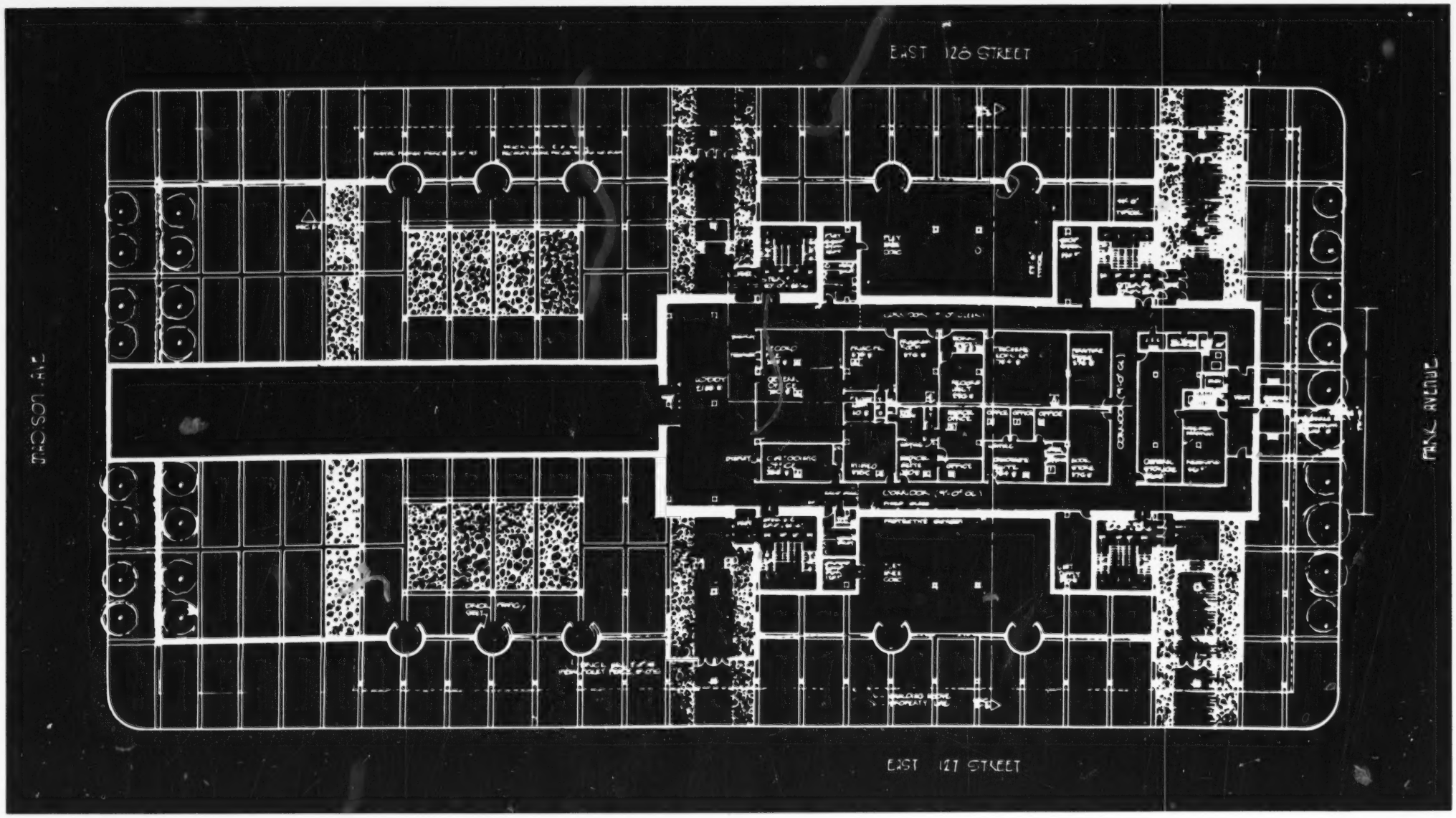
Structural Engineer:
Ames & Selnick,
New York City

This structure is a three story reinforced concrete school with a basement. Bids were opened in April 1964 and construction was started. The entire basement area (over 49,000 sq. ft. is below ground and contains a cafeteria, kitchen, and toilet facilities. This area can provide fallout shelter for more than 3,500 persons. The first, second, and third story floors are of 10-inch and 12-inch reinforced concrete slab construction. Approximately 5,000 sq. ft. of shelter area is available on the first floor which is above grade, and about 16,000 sq. ft. of shelter space is available on the second floor. There are no windows on the second floor and this enhances the protection afforded.

The shelter features were inherent in the basic building design and, therefore were included at no additional cost to the owner.

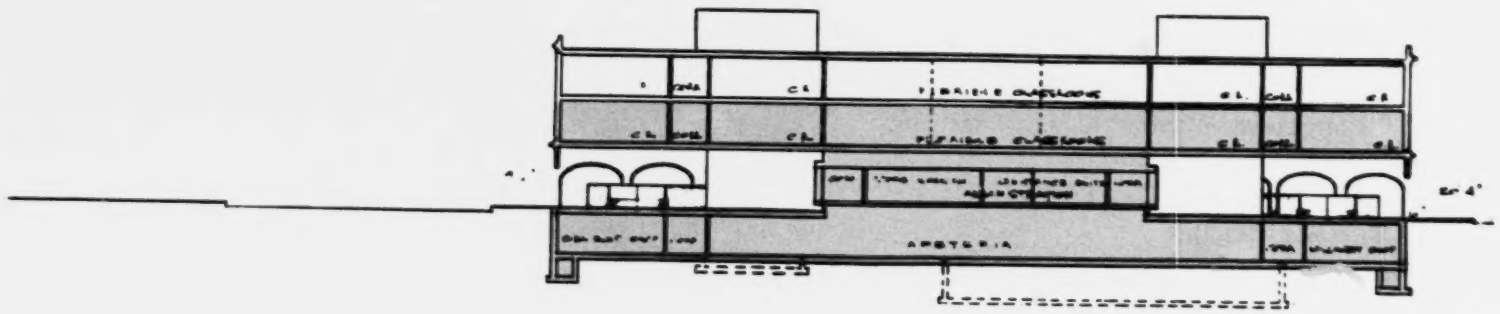
School capacity is 1,860; shelter capacity exceeds 5,600.



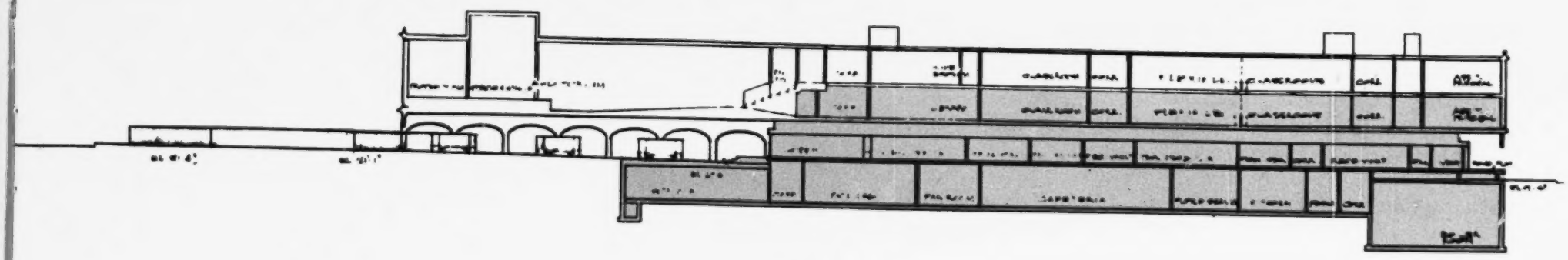


First Floor Plan

Section



Section



Schools

Cascade Junior High School

Location: Longview, Wash.
Owner: School District 122
Architect: McGuire & Muri, AIA, Tacoma, Wash.
Structural Engineer and Shelter Analyst: Victor K. Schegolkov, Seattle, Wash.
Mechanical Engineer: DeWitt C. Griffin, Seattle, Wash.
Electrical Engineer: Beverly A. Travis & Assoc., Seattle, Wash.

Project Cost: $1,405,588

Gross Area: 90,423 sq. ft.

Cost per sq. ft.: $15.54

Shelter Area: 18,000 sq. ft.

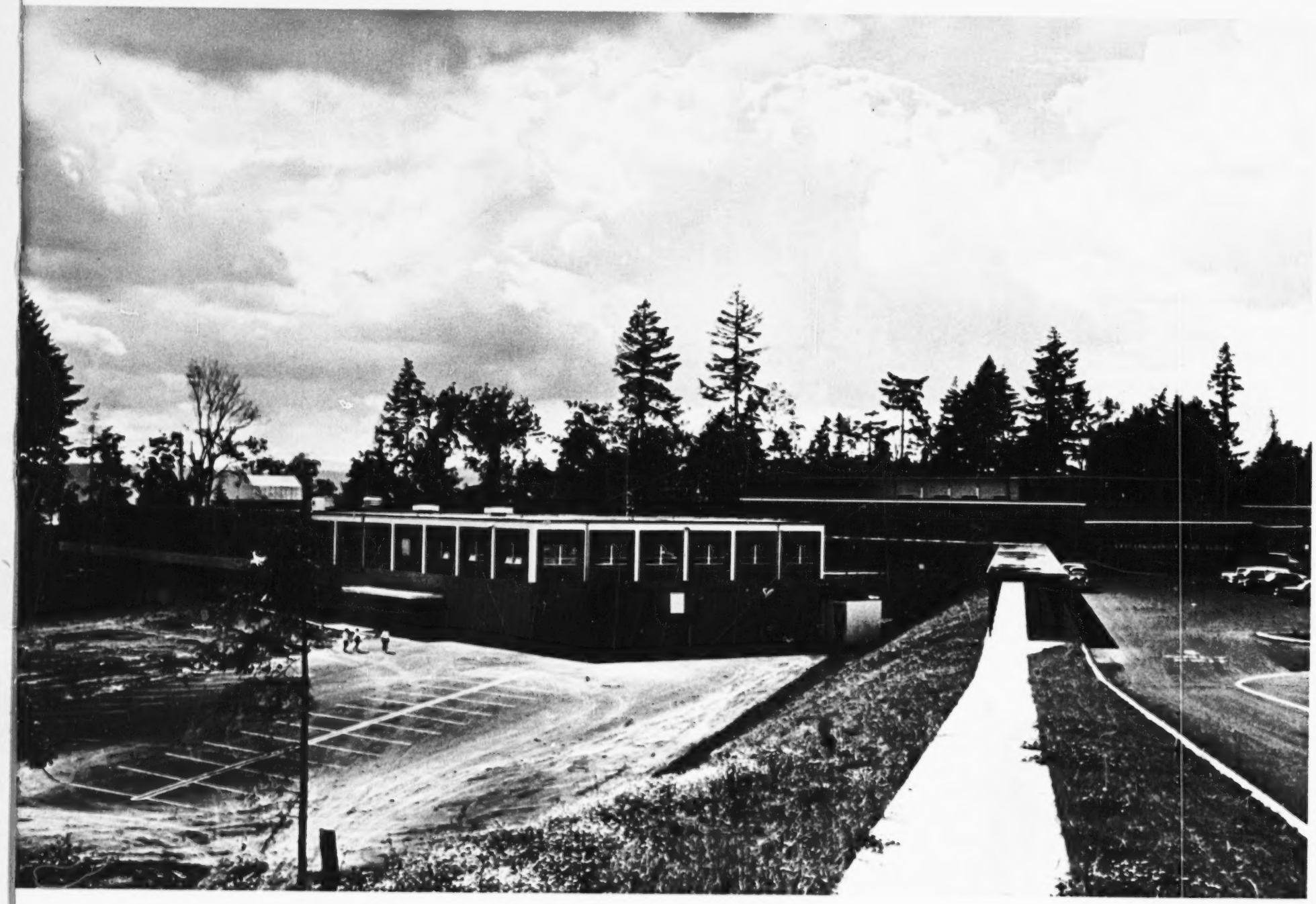
Shelter Cost:
General Construction: $15,000
Additional Equipment (mechanical, electrical, etc.): $18,000

Shelter General Construction Cost per sq. ft. of School Area: $0.17

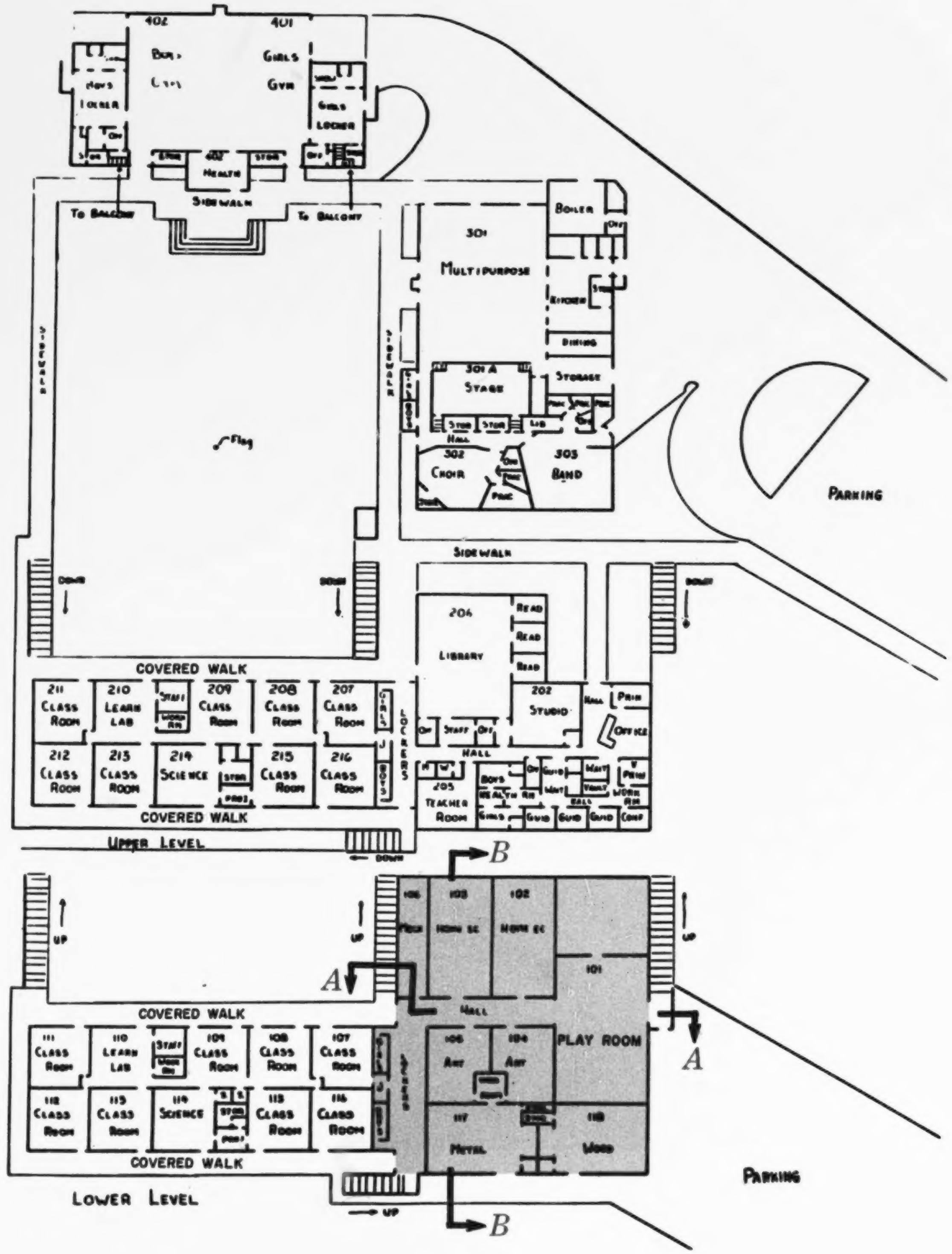
The Cascade Junior High School is a campus plan consisting of an above ground two-story reinforced concrete classroom and administration building, a multi-purpose and music building, and a gymnasium building. The latter two are one-story wood frame construction. School capacity is 850 pupils; shelter capacity is 1,800.

The shelter, which has a protection factor of more than 100, is located in a portion of the lower level of the classroom and administration building designated as the Metal, Woodworking, Arts and Crafts Shops and Home Economics Classrooms. The perimeter walls are 12 inches thick; ceiling slab is 8 inches thick reinforced concrete. In addition, the portion of the shelter within the main building is protected with a 5-inch thick, second story roof slab.

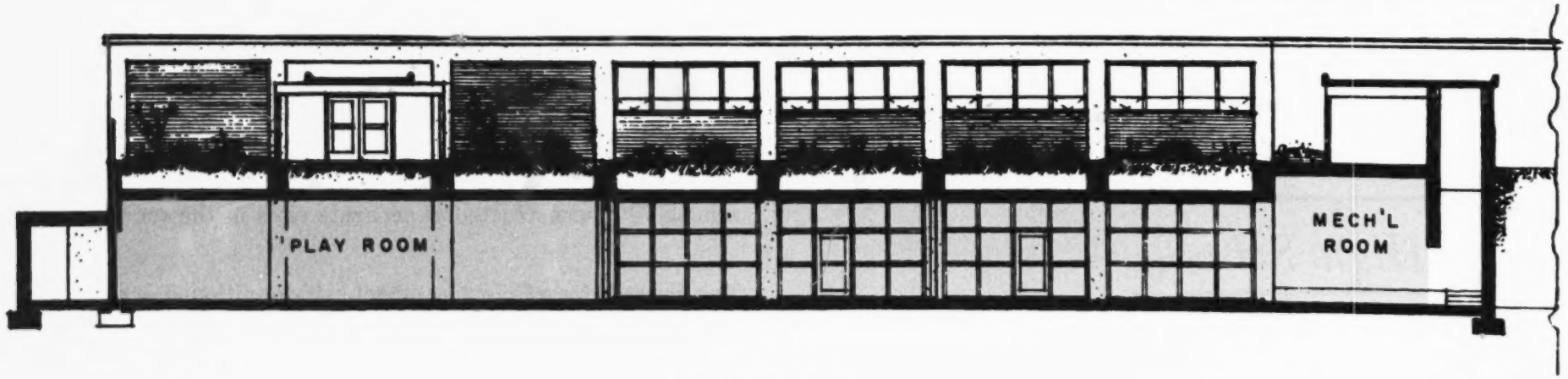
The additional equipment shown under shelter cost also includes $10,000 for electrical work, including a 50-kw emergency diesel generator. Also included is $5,000 for mechanical work. The cost for providing only the additional reinforced concrete to increase thickness of walls, ceiling, slab, beams, columns, and footings was $15,000.



Floor Plan

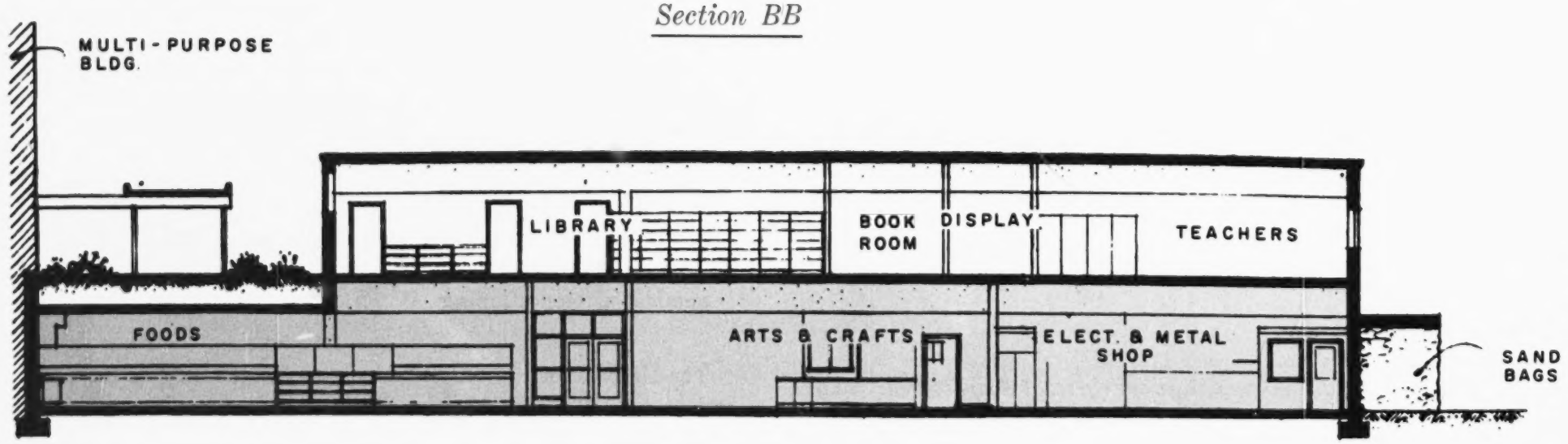


PARKING
PARKING
401
402
GIRLS GYM
HEALTH
SIDEWALK
TO BALCONY
TO BALCONY
301 MULTIPURPOSE
BOILER
KITCHEN
DINING
STORAGE
301 A STAGE
302 CHOIR
303 BAND
SIDEWALK
204 LIBRARY
202 STUDIO
OFFICE
HALL
205 TEACHER ROOM
LOCKERS
COVERED WALK
211 CLASS ROOM
210 LEARN LAB
209 CLASS ROOM
208 CLASS ROOM
207 CLASS ROOM
212 CLASS ROOM
213 CLASS ROOM
214 SCIENCE
215 CLASS ROOM
216 CLASS ROOM
COVERED WALK
UPPER LEVEL
DOWN
DOWN
DOWN
UP
UP
UP
HALL
PLAY ROOM
101
COVERED WALK
111 CLASS ROOM
110 LEARN LAB
109 CLASS ROOM
108 CLASS ROOM
107 CLASS ROOM
112 CLASS ROOM
113 CLASS ROOM
114 SCIENCE
115 CLASS ROOM
116 CLASS ROOM
COVERED WALK
LOWER LEVEL
A
A
B
B



Section AA

Section BB



Schools

Union Park, Robinswood, & Carver Junior High Schools

Location: Orange County, Fla.
Owner: Board of Public Instruction,
Orange County, Fla.
Associated Architects:
Lawrence L. Anglin, AIA, Robert B. Murphy, AIA,
John P. DeLoe, AIA,
Orlando, Fla.
Shelter Analyst:
Lawrence L. Anglin, AIA
Project Cost:

Union Park	$434,000
Robinswood	450,000
Carver	432,000
Total	$1,316,000

Gross Area: 3 @ 26,425 sq. ft. equals 79,275 sq. ft.

Cost per sq. ft.: $16.60

Shelter Area: 3 @ 9,880 sq. ft. equals 29,640 sq. ft.

Shelter Cost: $46,460

Shelter General Construction Cost per sq. ft. of School Area: $0.59.

The architects were commissioned by the Orange County, Fla., Board of Public Instruction to design three identical, junior high schools to be constructed at separate sites in the county.

The criteria for efficient compact, air-conditioned schools minimized the amount of exterior wall and the number of exterior openings in these walls. The desire to create large expanses of flexible space necessitated a flat, rigid ceiling structure and this requirement influenced the architects to select Lift Slab construction in an aboveground single story school.

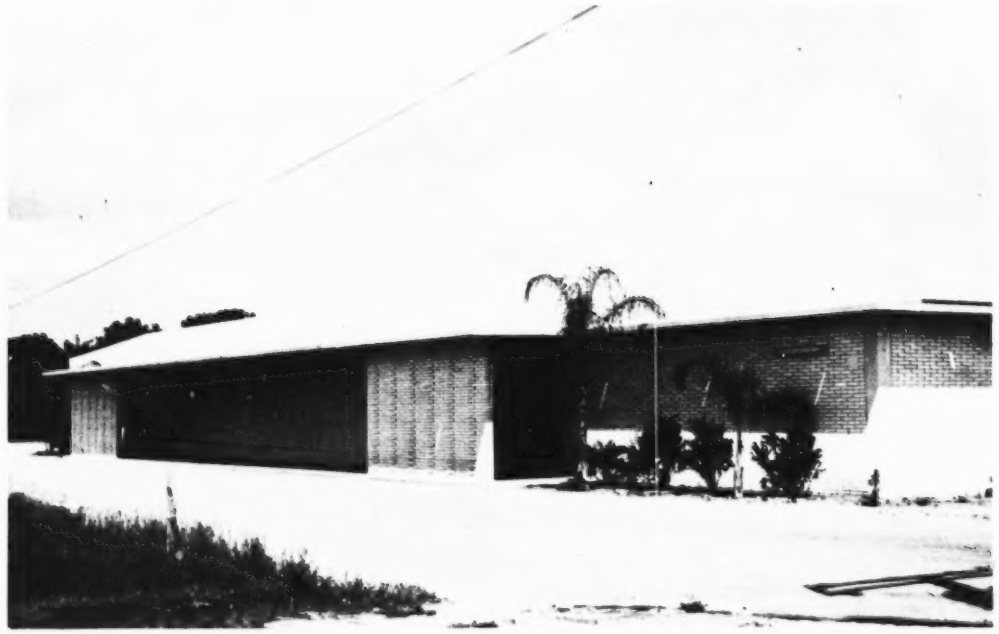
With a natural core area and a concrete roof, the Shelter Analyst advocated going a step further and incorporating fallout shelter space in the three schools. The decision to proceed in this direction created no design problem: a relatively small amount of additional concrete in the roof slab with three inches of sand and cement topping plus filling the hollow concrete block with sand gave the required protection factor at a minimum of additional cost. No additional air-conditioning and ventilating was required.

Shelter space was provided in all three schools in the core area which was also utilized as active teaching space. The building was conceived with minimum window openings for more economical air-conditioning.

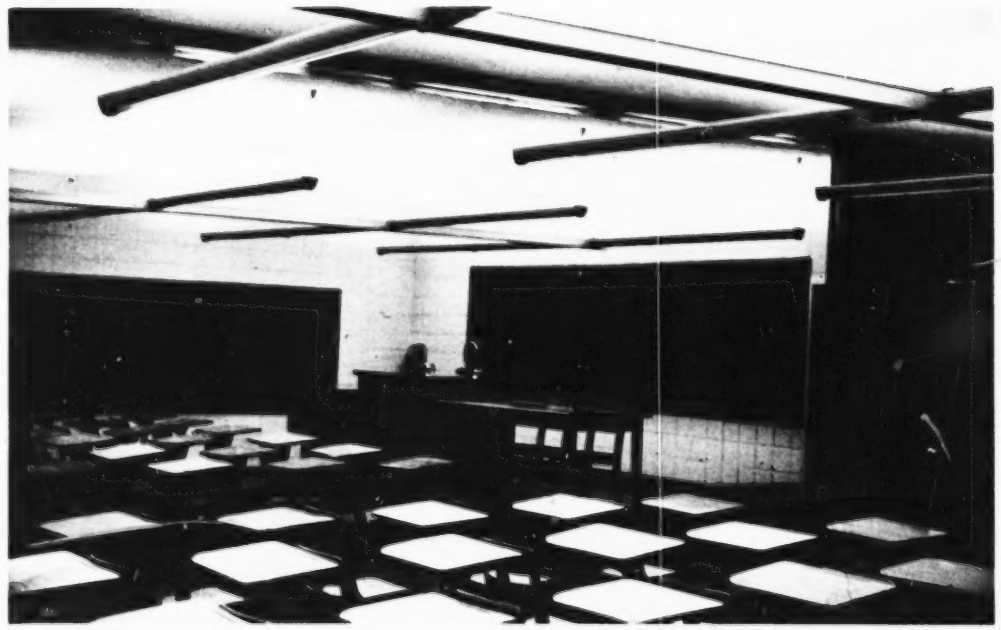
The Union Park, Robinsonswood and Carver Schools have a student capacity of 600 each. Total shelter capacity in the three schools is 2,964.

H
Goldman.

UNION PARK JR. HIGH SCHOOL
Exterior View



UNION PARK JR. HIGH SCHOOL
Classroom in Shelter Area



ROBINSWOOD JR. HIGH SCHOOL

CARVER JR. HIGH SCHOOL
Baffled Entranceway

UNION PARK JR. HIGH SCHOOL
Corridor—Shelter to Left

Schools

Bemus Point Junior-Senior High School

Location: Chautauqua County, N.Y.
Owner: Bemus Point Central School District, Bemus Point, N.Y.
Architect: Julian Naetzker, Jamestown, N.Y.
Mechanical Engineer: William Standeven, Buffalo, N.Y.
Structural Engineer: Dr. Louis Petro, Rolla, Mo.
Shelter Analyst: Julian Naetzker

Project Cost: $1,897,551

Gross Area: 116,000 sq. ft.

Cost per sq. ft.: $16.36

Shelter Area: 11,000 sq. ft.

Shelter Cost:
General Construction: $17,500
Additional Equipment (mechanical, electrical, etc.): $7,500

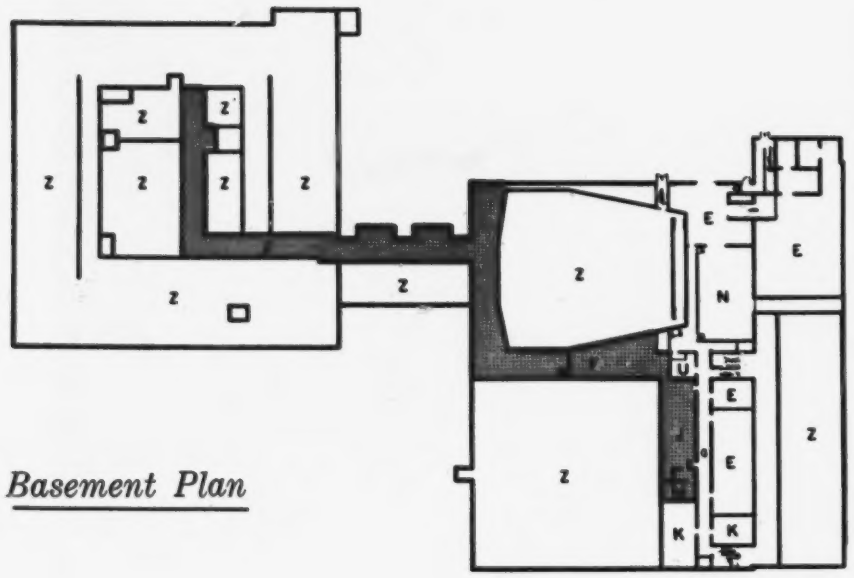
Shelter General Construction Cost per sq. ft. of School Area: $0.15

This school is presently under construction and occupancy is anticipated in September 1965.

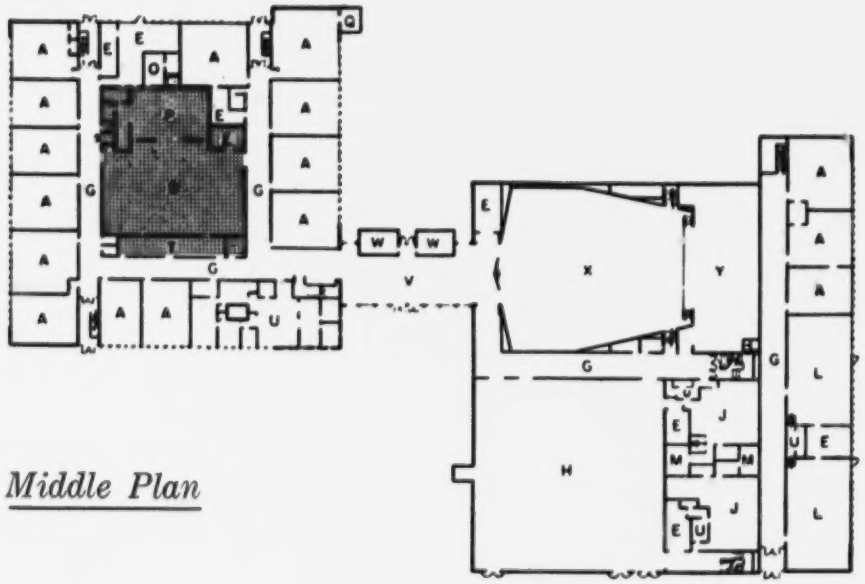
In establishing the programing data, the Board of Education decided that the design for the new Junior-Senior High School should incorporate a fallout shelter to accommodate the 1,000-pupil capacity of the new building as well as the approximate 80 to 100 staff members who might be in the building at the time of nuclear attack. The decision to provide fallout shelter facilities played an important part in the design process. The project took shape in two basic rectangular forms, offset with a connecting one-story lobby. In working out the Schematic Studies for the structure, the decision was made to have a cafeteria located in the core of the "quiet" wing and have it act as the fallout shelter core in the event of nuclear attack. A pipe tunnel connects the cafeteria-activity-core with the team lockers in the basement of the "high sound level" wing thus providing access from toilet and shower facilities to the cafeteria area.

As the structure is located in the countryside away from municipal water or sewage facilities an on-the-site sewage disposal plant is provided for normal operation. An on-the-site water well system is also incorporated in the design. The sewage disposal plant, in the event of nuclear emergency, will operate satisfactorily without electrical power being provided to the chlorination plant. As no pumps are involved, the gravity flow will operate the system. A 75-kw generator is incorporated in the design and will provide emergency power for the water well pump as well as for lighting, ventilation, and food preparation requirements.

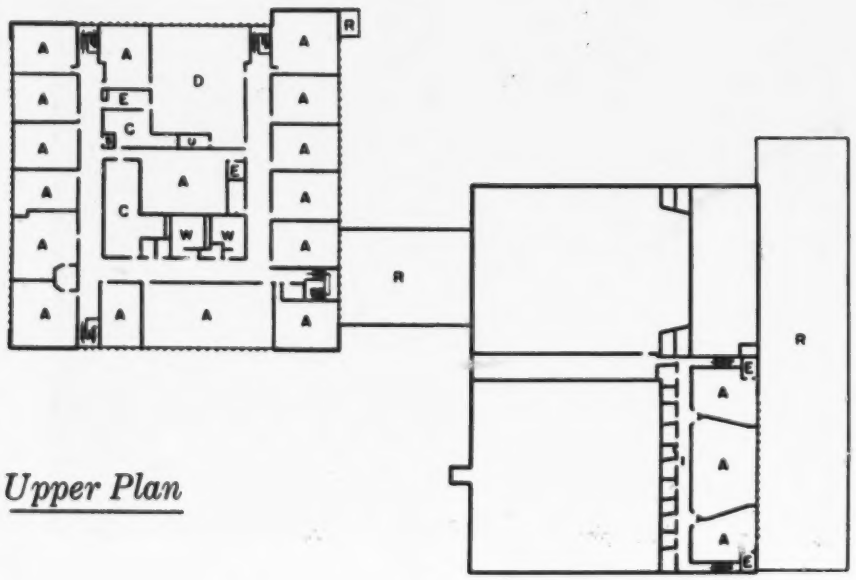
The school has a capacity of 1,000 and can accommodate 1,100 for shelter purposes with a protection factor of 100.



Basement Plan



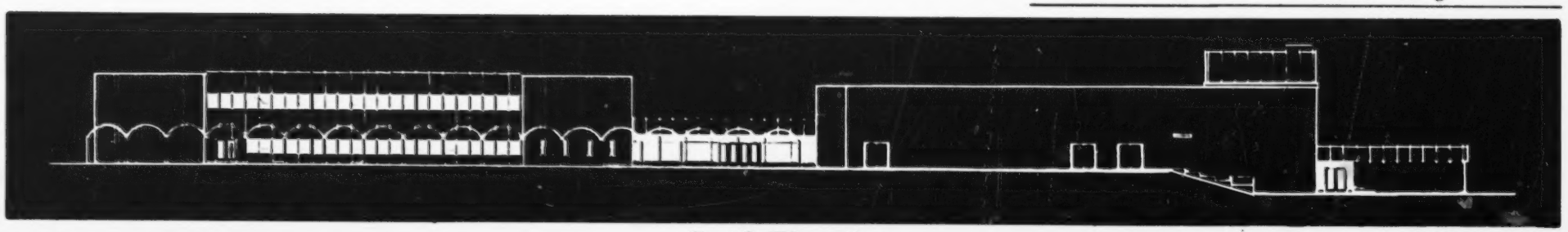
Middle Plan



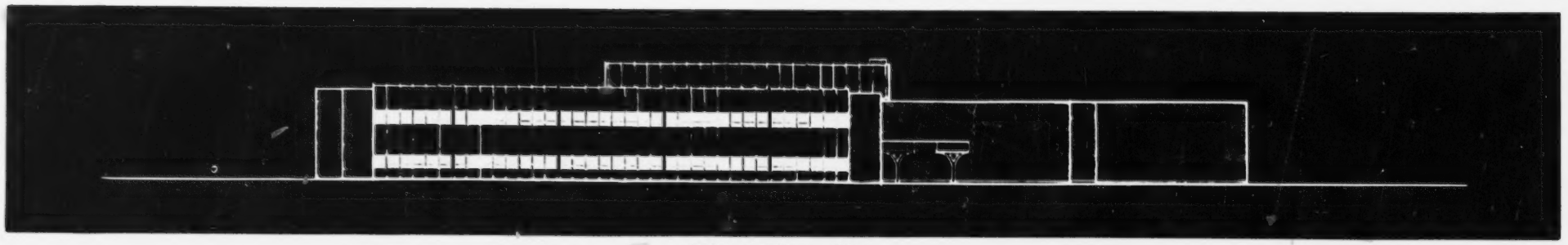
Upper Plan

FALLOUT SHELTERS

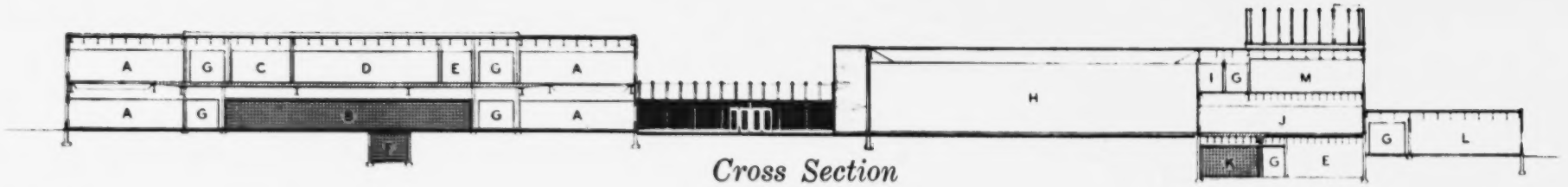
A. Classrooms
B. Cafeteria
C. Teachers Room
D. Library
E. Storage
F. Tunnel
G. Corridor
H. Gymnasium
I. Practice Rooms
J. Locker Rooms
K. Laundry and Drying
L. Shops
M. Showers
N. Boiler Room
O. Food Storage
P. Kitchen
Q. Green House
R. Roof
S. Elevator
T. Teachers Dining
U. Office
V. Lobby
W. Lavatories
X. Auditorium
Y. Stage
Z. Unexcavated



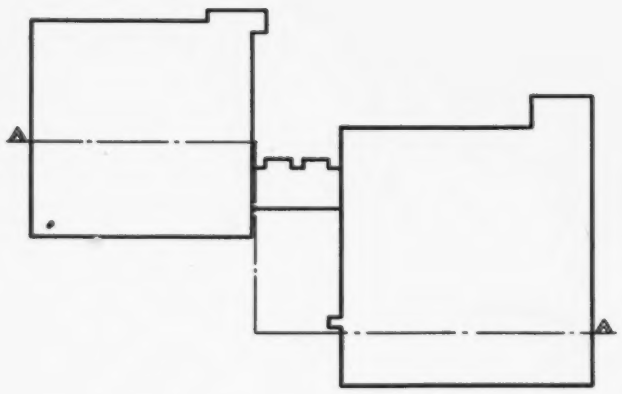
South Elevation



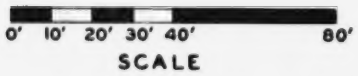
West Elevation



Cross Section



- *A. Classrooms*
- *B. Cafeteria*
- *C. Teachers Room*
- *D. Group Instruction*
- *E. Storage*
- *F. Tunnel*
- *G. Corridor*
- *H. Gymnasium*
- *I. Broadcasting*
- *J. Locker Room*
- *K. Team Room*
- *L. Wood Shop*
- *M. Music Room*



CONCRETE SLAB OVER SHELTER AREAS

FALLOUT SHELTER AREAS

Schools

Center Senior High School

Location: 88th and Holmes Road,
Kansas City, Mo.
Owner: Center School District No. 58,
Kansas City, Mo.
Architect-Engineer: Marshall and Brown, AIA,
Kansas City, Mo.

Project Cost: $2,156,000

Gross Building Area: 150,065 sq. ft.

Cost per sq. ft.: $14.37

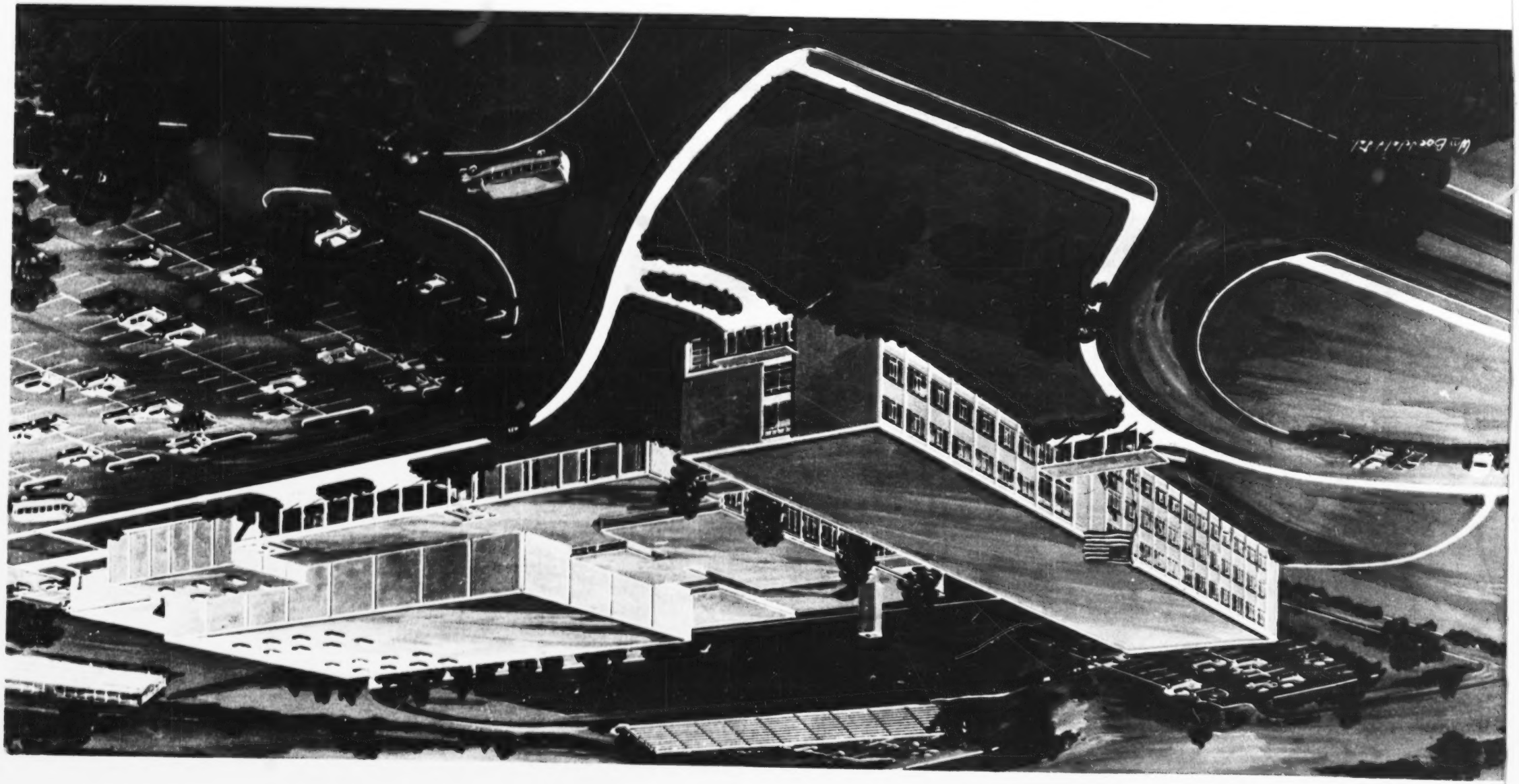
Shelter Area: 11,116 sq. ft.

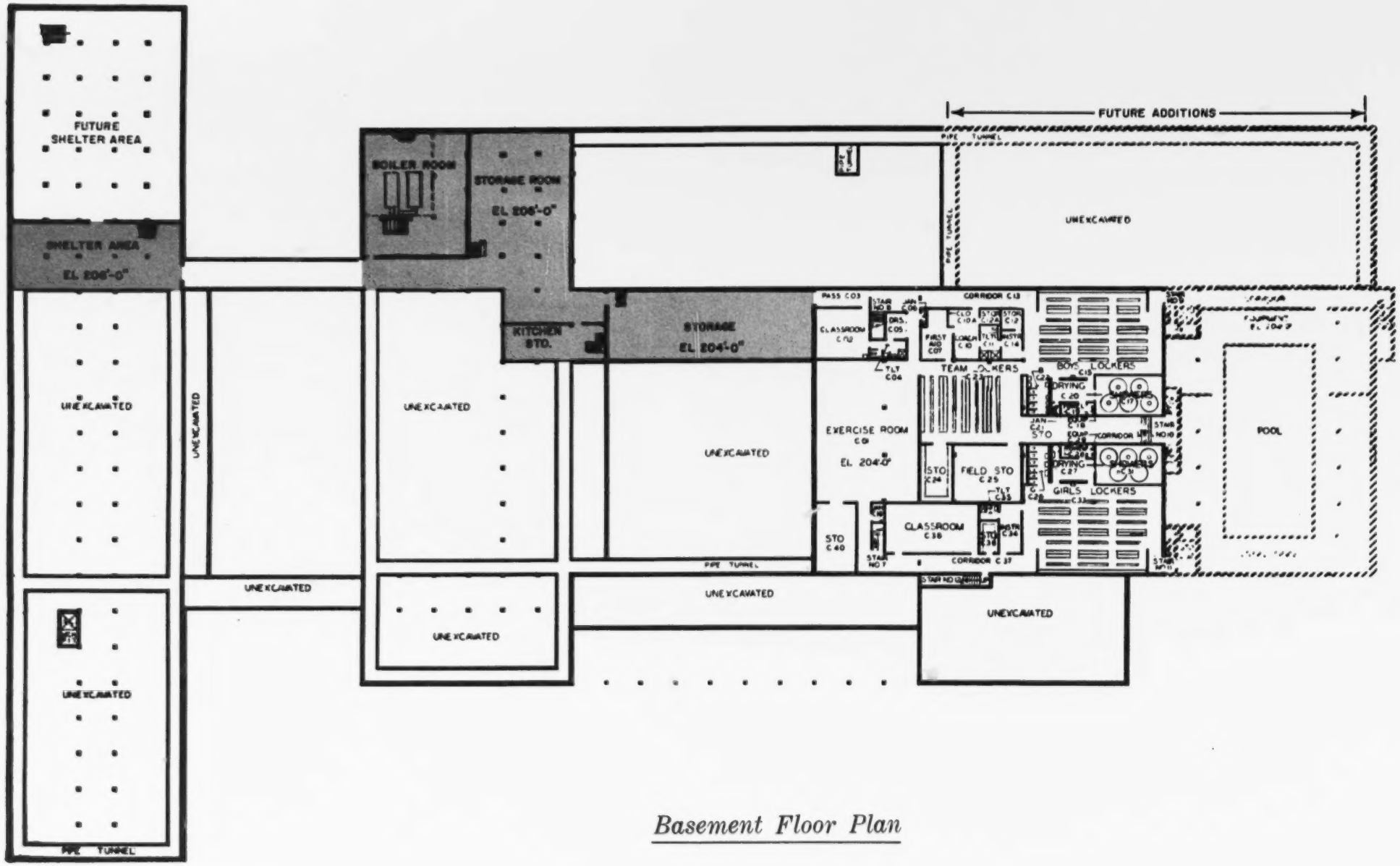
Shelter Cost: *None*—inherent in basic design

Center Senior High School consists of two structures joined together with covered corridors on either side of an open court. A four-story building (with one story belowground) contains most of the classrooms, library, and office space. The second building contains an auditorium, gymnasium, cafeteria, music room, and several miscellaneous classrooms. Fallout shelter areas, with protection factors varying from 40 to 500, are available in the basements of both buildings. The shelter can accommodate 685 persons.

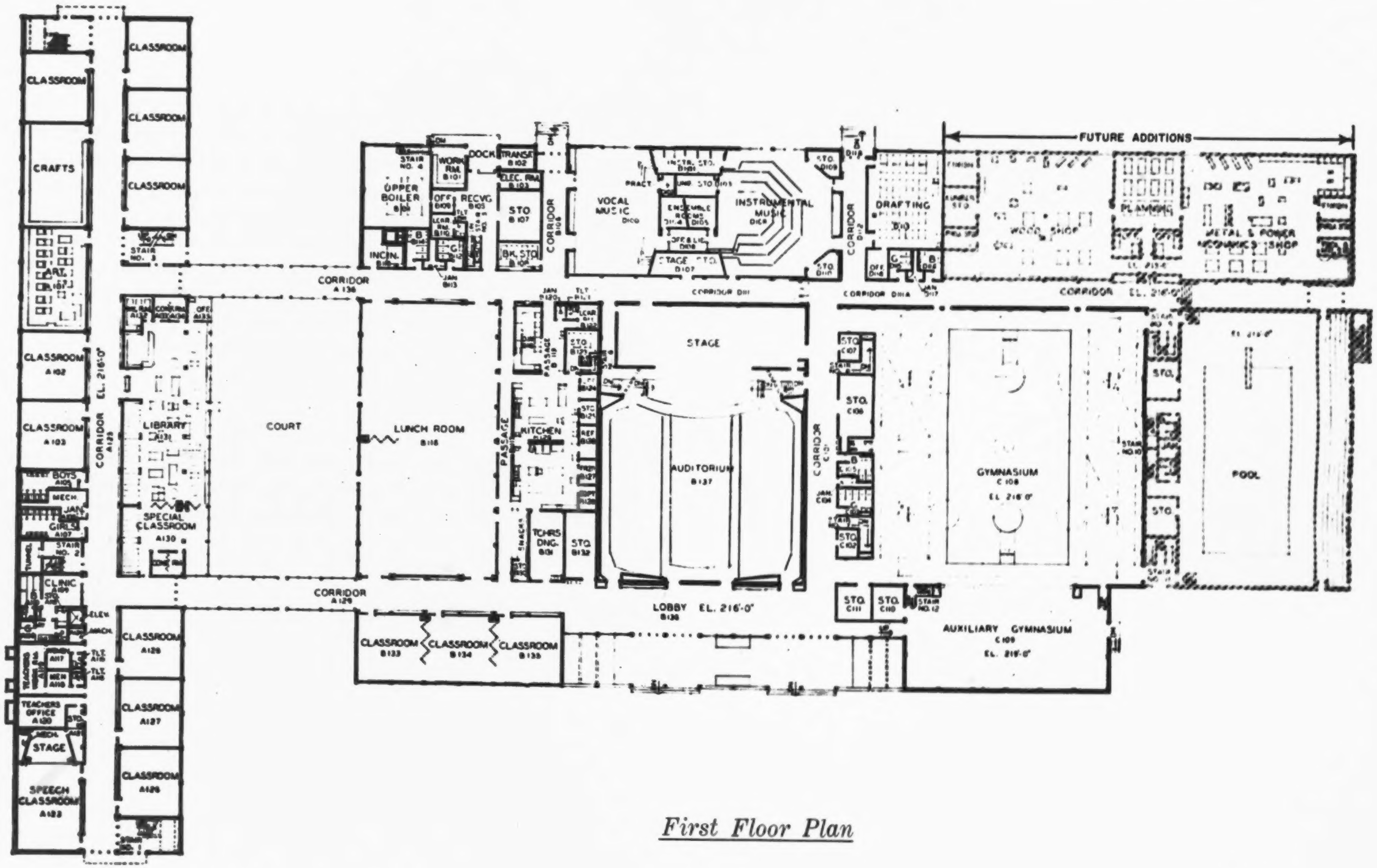
Provisions have been made for expansion of the school building in future additions which will also include shelter area. Since the school is located in the midst of the "tornado belt" the shelter areas are also suitable as emergency tornado shelters for the students.

Shelter was incorporated as part of the normal design and construction of the school and there was no increase in school cost.





Basement Floor Plan



First Floor Plan

Schools

Lincoln Elementary School

Location: Alva, Okla.
Owner: Board of Education,
Alva, Okla.
Architect: Dow Gumerson, AIA,
Oklahoma City, Okla.
Structural Engineer:
Sullivan Engineering Co.,
Oklahoma City, Okla.
Mechanical and Electrical Engineers:
Davis & Rountree,
Oklahoma City, Okla.
Shelter Analyst:
Dow Gumerson, AIA,
Oklahoma City, Okla.

Project Cost: $201,000

Building Area: 16,500 sq. ft.

Cost per sq. ft.: $12.12

Shelter Area: 2,565 sq. ft.

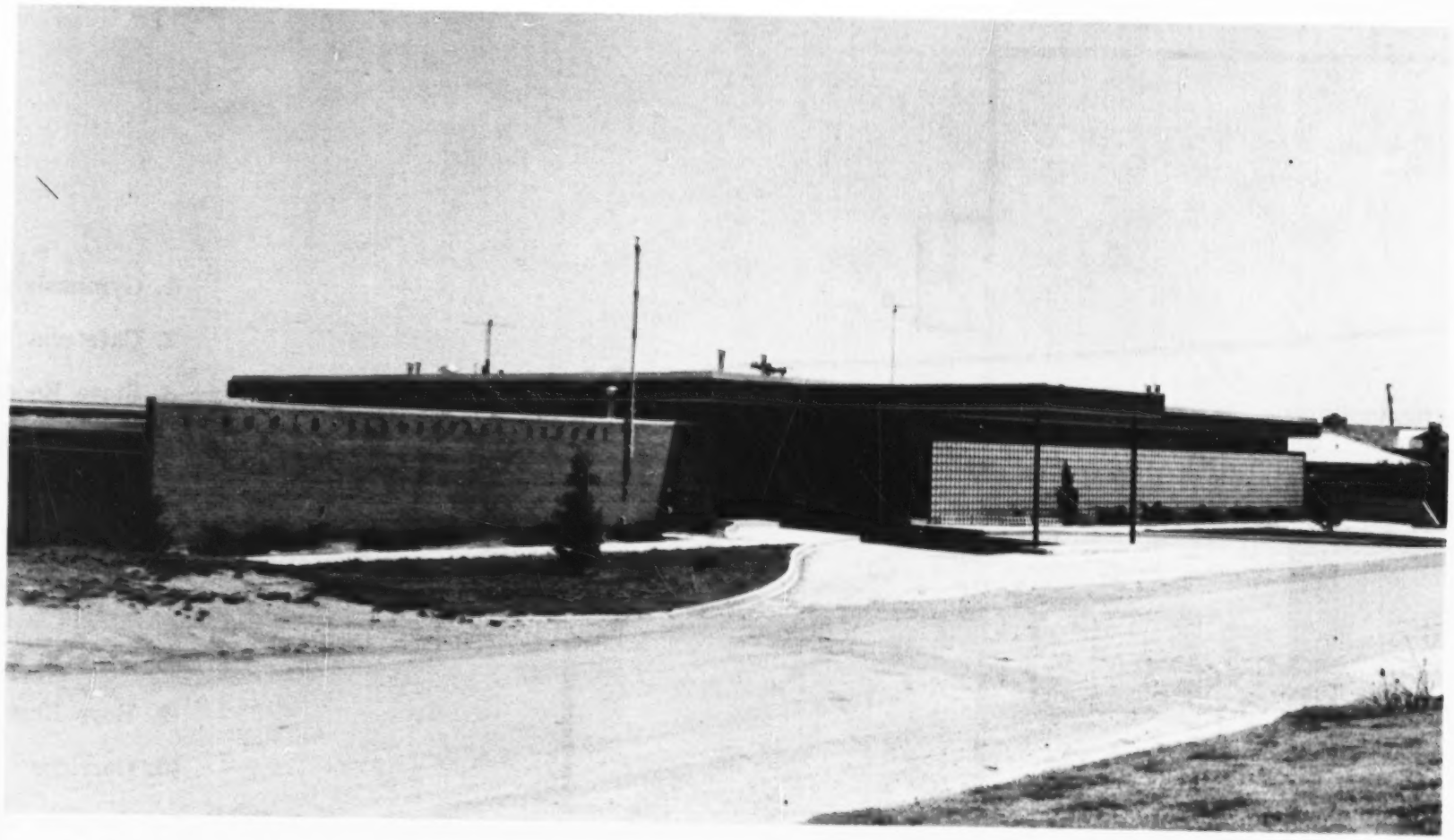
Shelter Cost:
General Construction: $5,130
Additional Equipment: None

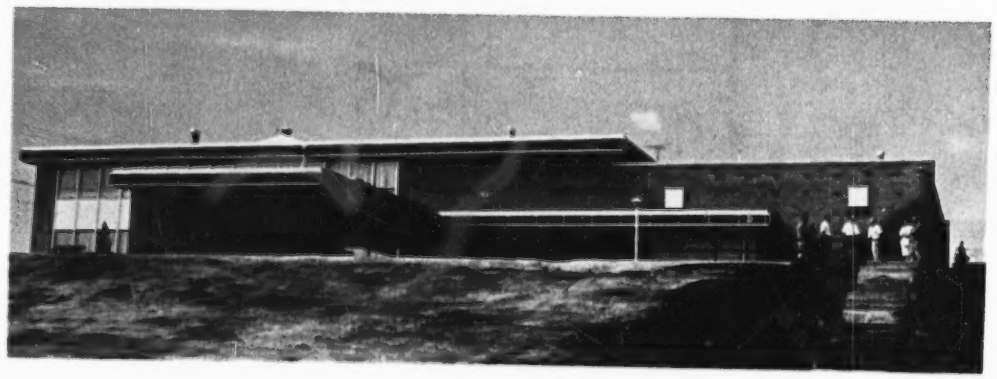
Shelter Cost per sq. ft. of School Area: $0.31

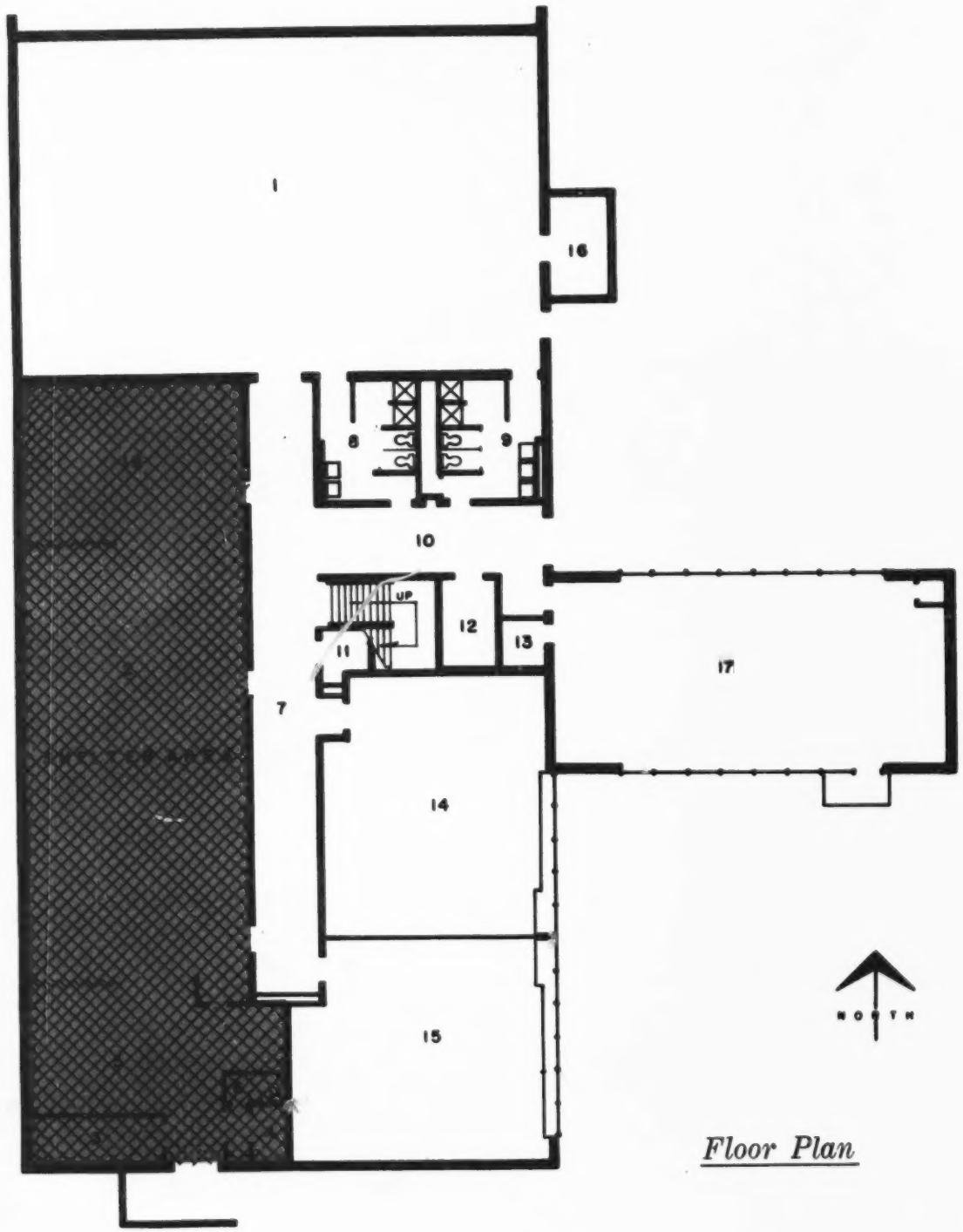
The school is built on a sloping site and has two levels. The building includes seven classrooms, a large kindergarten room, cafeteria, a spacious gymnasium, office space, and janitor's storage. The lower level, which houses the combination cafeteria, auditorium, and music room, serves as the shelter area and provides a protection factor exceeding 100. Because of the natural lay of the land this level is actually belowground on three sides of the building but has a ground level entrance on the fourth side. The roof of the shelter is constructed of 17 inches of reinforced concrete. The cafeteria and auditorium also provide tornado shelter.

On the side of the school which has both stories fully exposed, the site was graded to provide a slope away from the building. This further enhanced the fallout protection offered by the school.

Present enrollment in the school is 165, and the shelter area has a capacity of 256.

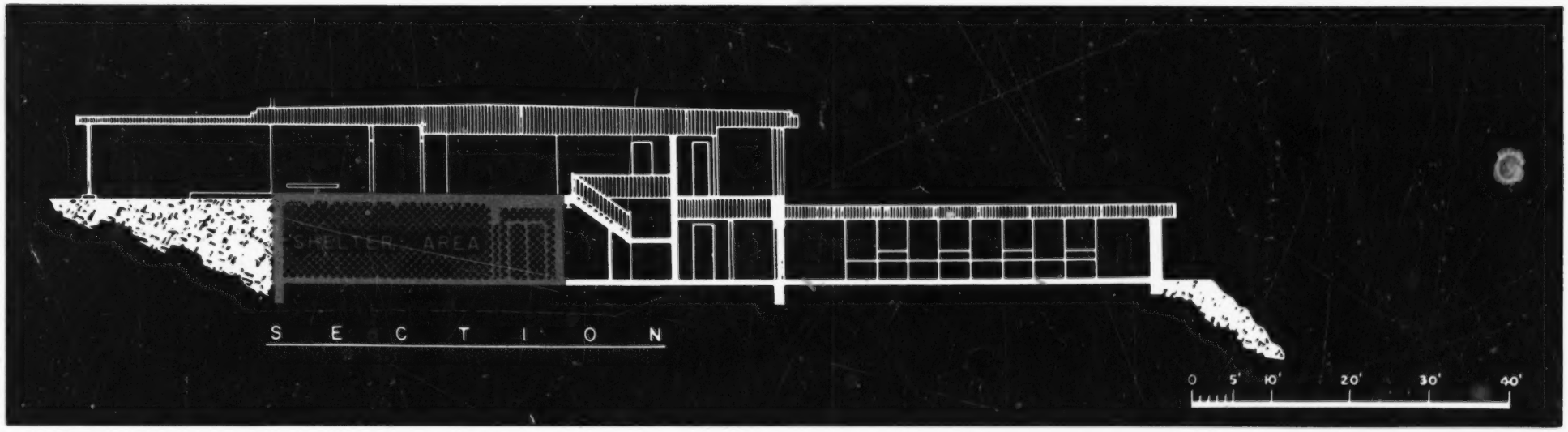


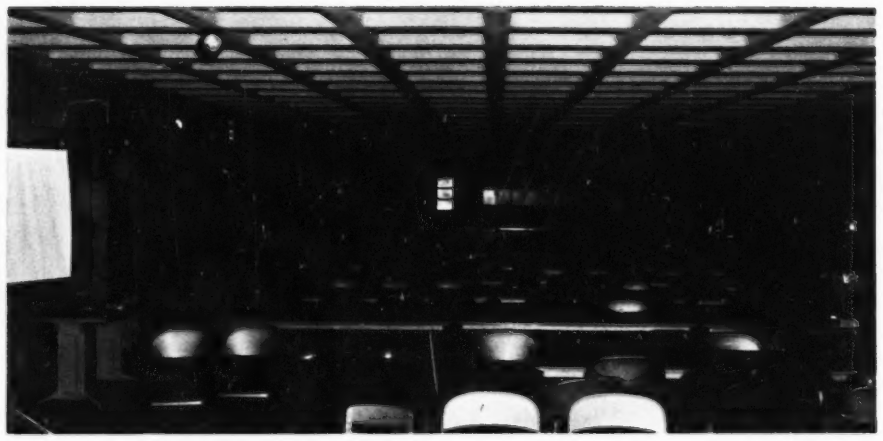




Floor Plan

1. Gymnasium
2. Cafeteria
3. Store Room
4. Heater Room
5. Kitchen
6. Toilet
7. Corridor
8. Girls Rest Room
9. Boys Rest Room
10. Corridor
11. Janitor
12. Storage
13. Toilet
14. Class Room
15. Class Room
16. Storage
17. Kindergarten
18. Music Room


SHELTER AREA
S E C T I O N
0 5' 10' 20' 30' 40'



Schools

Miami Carol City Senior High School

Location: 3422 NW. 187th Street, Dade County, Miami, Fla.
Owner: Board of Public Instruction,
Dade County, Fla.
Architect: Wahl Snyder and Associates,
Miami, Fla.
Shelter Analyst:
R. L. Duffer Associates

Project Cost: $1,638,508

Gross Area: 136,000 sq. ft.

Cost per sq. ft.: $12.05

Shelter Area: 21,300 sq .ft.

Shelter Cost:
General Construction: $7,900
Additional Equipment (mech., elect., plumbing, etc.): $19,500

Shelter General Construction Cost per sq. ft. of School Area: $0.06

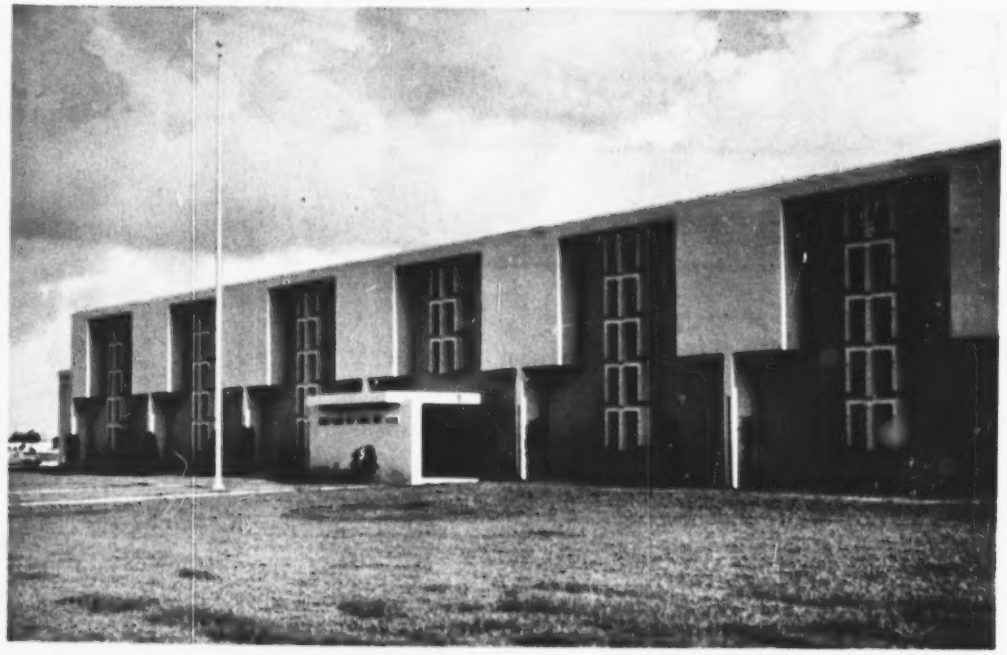
This school is a two-story aboveground structure of reinforced concrete construction. The school is centrally air-conditioned and has shelter space included in the ground floor. This is dual-purpose space which is used normally as a cafeteria and library area. Minimum windows are provided to permit the most economical air-conditioning.

Exposed entranceways are screened by means of buffer walls fabricated from hollow concrete block filled with sand. The sand-fill technique was also used in other walls where needed to improve fallout protection.

Portable fans are provided for the shelter space and can be driven either electrically or by hand. Emergency power is provided by an engine generator which connects to outlets in the shelter area. A water well has also been provided for emergency use.

The school has a capacity of 1,400 students and can accommodate 1,750 persons in the shelter area which has a protection factor of 100. The shelter costs shown include mechanical work, $7,900; plumbing, $2,600; and emergency generator and electrical, $9,000. These are in addition to the shielding costs.

Exterior View



Shelter Area in Library

Schools

Glades Junior High School

Location: Miami, Fla.
Owner: Board of Public Instruction, Dade County, Fla.
Architect: T. Trip Russell and Associates, AIA, Miami, Fla.
Shelter Analyst: James O. Power, Miami, Fla.

Project Cost: $1,132,300

Gross Area: 96,882 sq. ft.

Cost per sq. ft.: $11.69

Shelter Area: 14,720 sq. ft.

Shelter Cost:
General Construction: $6,680
Additional Equipment (mechanical, electrical, etc.): $11,720

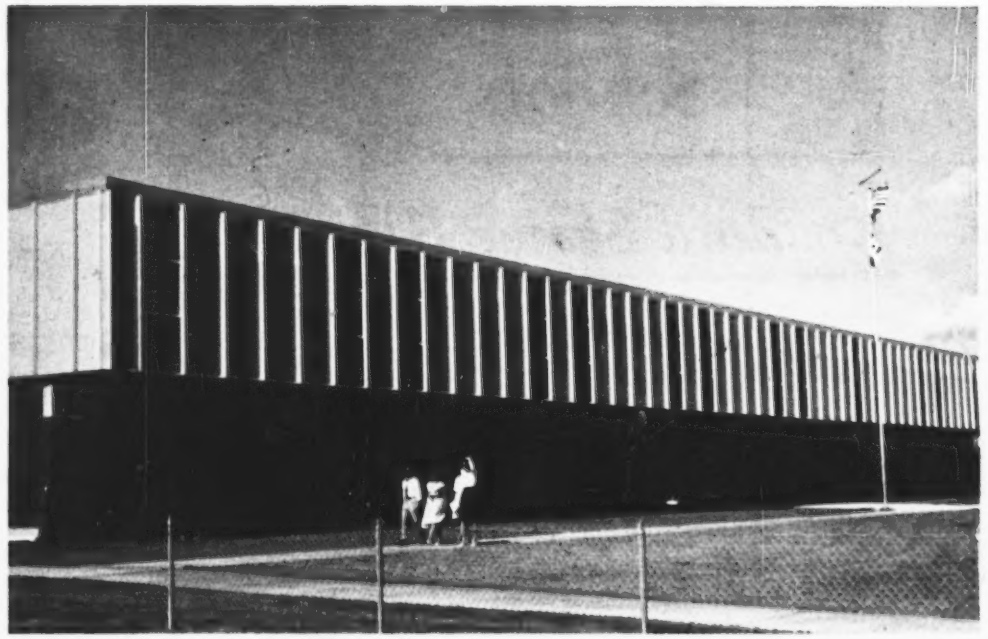
Shelter General Construction Cost per sq. ft. of School Area: $0.07

This is a two-story structure of reinforced concrete construction having a shelter space with a protection factor of 100 on the first floor. The shelter area is in space used daily as a cafeteria on one side of a corridor and as an auditorium on the other side. The auditorium extends through two floors and the mass thickness of the auditorium roof was increased to provide protection to the occupants.

The building has central air-conditioning and is provided with portable fans for emergency ventilation. Shelters are linked to outside air by ducts which terminate in walls of the shelter areas where fans are to be connected in emergency. The number of exterior windows was minimized to provide economical air-conditioning.

The shelter space in the school is planned for use of the surrounding community as well as by the students and staff. Student capacity is 1,200. Shelter capacity is 1,472.

Exterior View



Auditorium in Shelter Area

Schools

Goddard Senior High School

Location: Roswell, N. Mex.
Owner: Board of Education, Roswell Municipal School District No. 1,
Roswell, N. Mex.
Architect: Frank M. Standhart, AIA,
Roswell, N. Mex.
Shelter Analyst:
Dr. Marcello Giomi, P.E.,
Albuquerque, N. Mex.

Project Cost: $1,944,070 (Building turn key)

Gross Area: 186,273 sq. ft.

Cost per sq. ft.: $10.42

Shelter Area (gross): 82,273 sq. ft.

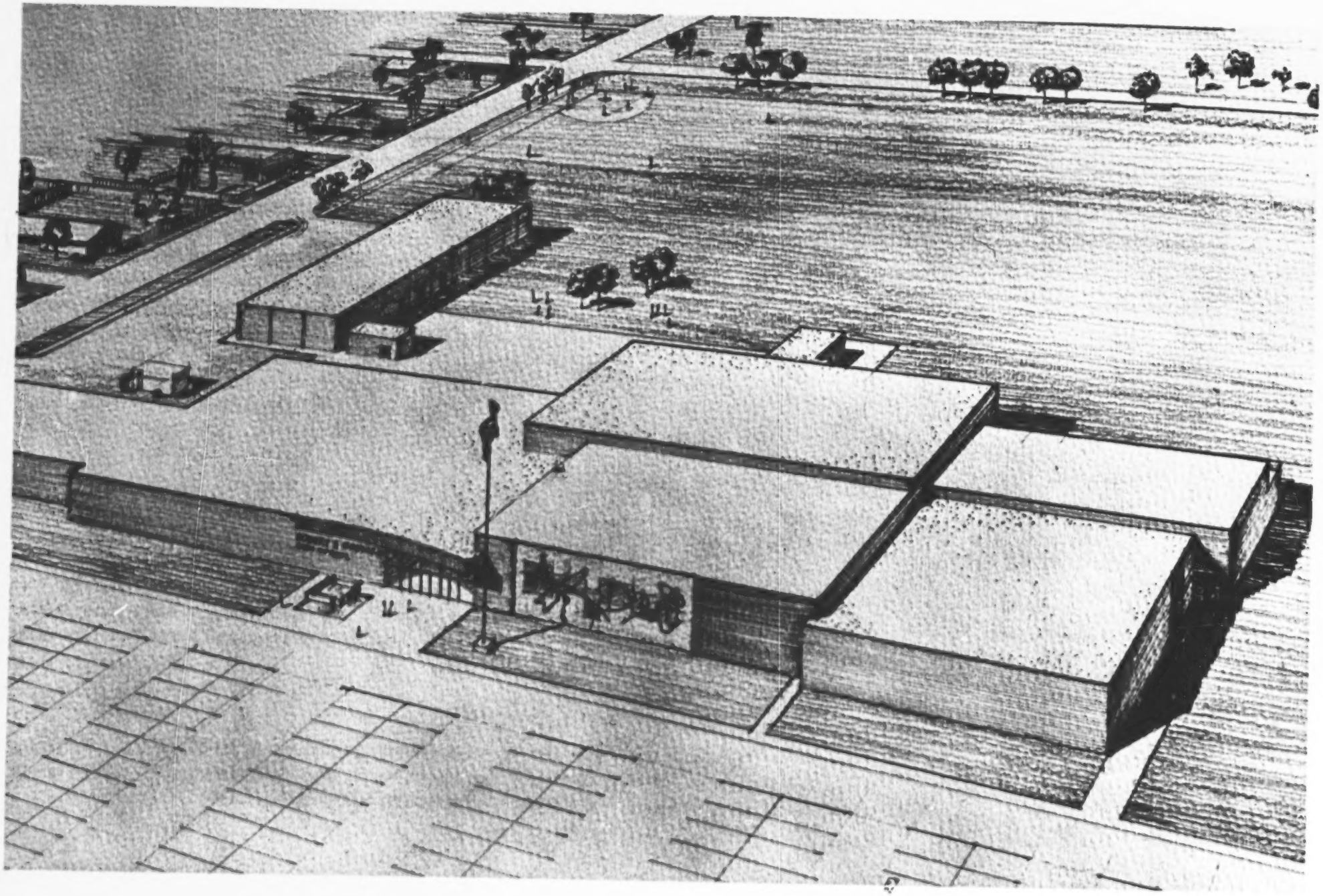
Shelter Cost:
General Construction: $13,000
Additional Equipment (mechanical, electrical, etc.): $117,000

Shelter General Construction Cost per sq. ft. of School Area: $0.07

In January 1964, a contract was awarded for the construction of this basement and ground floor, air conditioned, windowless school. Approximately 100,000 sq. ft. of the structure is above-ground and consists of a boy's gymnasium, a girls' gymnasium, auditorium, dining room, bandroom, home economics department, manual arts, and automotive shops, and a central kitchen where all the meals for the city school system are prepared. The below-ground portion will be primarily occupied by classrooms and laboratories and will serve a dual purpose in providing fallout shelter space.

Two artesian water wells capable of delivering 1,550 gallons per minute will be provided for air conditioning needs and human consumption. Local building code required this to be furnished as part of normal school facility. A 625-kva diesel engine driven generator and a 20,000-gallon diesel fuel storage tank are included as well as sewage ejection pumps. Under fallout conditions, all fresh air will be passed through high efficiency particulate filters. Approximately 5,100 feet of the shelter area is allotted to the storage of necessary survival supplies.

The school has a student population of 2,000. Fallout shelter capacity is 6,500. Protection factor exceeds 600.



Schools

Park Junior High School

Location: Artesia, N. Mex.
Owner: Board of Education, Artesia Municipal School District No. 16
Architect: Frank M. Standhardt, AIA, Roswell, N. Mex.
Shelter Analyst: Dr. Marcello Giomi, P.E., Albuquerque, N. Mex.

Project Cost: $1,111,147

Gross Area: 95,623 square feet

Cost per sq. ft.: $11.61

Shelter Area (gross): 34,126 sq. ft.

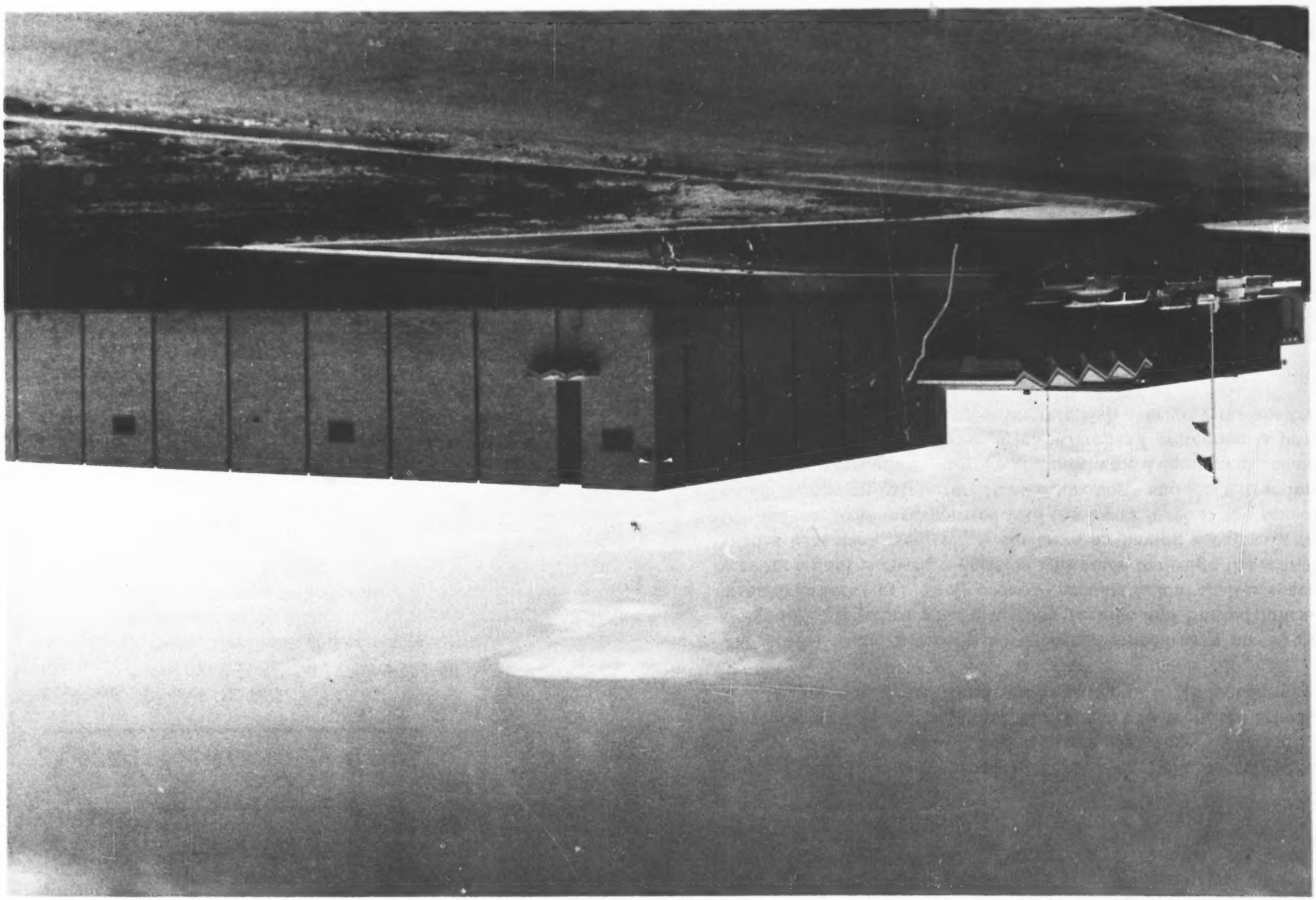
Shelter Cost:
General Construction: $10,000
Additional Equipment (mechanical, electrical, etc.): $49,200

Shelter General Construction Cost per sq. ft. of School Area: $0.10

This windowless, air-conditioned, light- and sound-conditioned teaching facility was completed in August 1964. The structure is comprised of a ground floor level (approximately 61,500 sq. ft.) and a basement (approximately 34,100 sq. ft.). The aboveground portion of the school consists of a gymnasium, shop, band and choral room, food, clothing and typing laboratories, science rooms, arts and crafts room, boys and girls locker rooms, kitchen and dining rooms, storage rooms, and corridors. The below-ground portion, which also serves a dual purpose in providing fallout shelter space consists essentially of classrooms, a library, boys and girls toilets, faculty and administrative rooms, language room, storage and mechanical equipment rooms and corridors.

The local construction code would normally have required a standby electric generator unit costing on the order of $5,000. In order to satisfy the power requirements for utilization of the school as a fallout shelter, a larger diesel engine generator was installed (cost $29,000). The independent water supply is also a requirement for normal facility usage and hence is not included in the shelter cost.

The school has a student population of 1,000. Shelter space for necessary supplies and occupancy by approximately 2,275 persons is available. Protection factor exceeds 600.



Schools

North Central School

Location: Rogers, N. Dak.
Owner: North Central School District No. 65
Architect: Wells, Denbrook & Associates, Grand Forks, N. Dak.
Shelter Analyst: Stanley S. Johnson, Grand Forks, N. Dak.

Total Cost: $468,000

Gross Area: 43,000 sq. ft.

Cost per sq. ft.: $10.88

Shelter Area: 6,500 sq. ft.

Shelter Cost:
General Constrution: $9,000*
Additional Cost: $21,000*

Shelter General Construction Cost per sq. ft. of School Area: $0.21

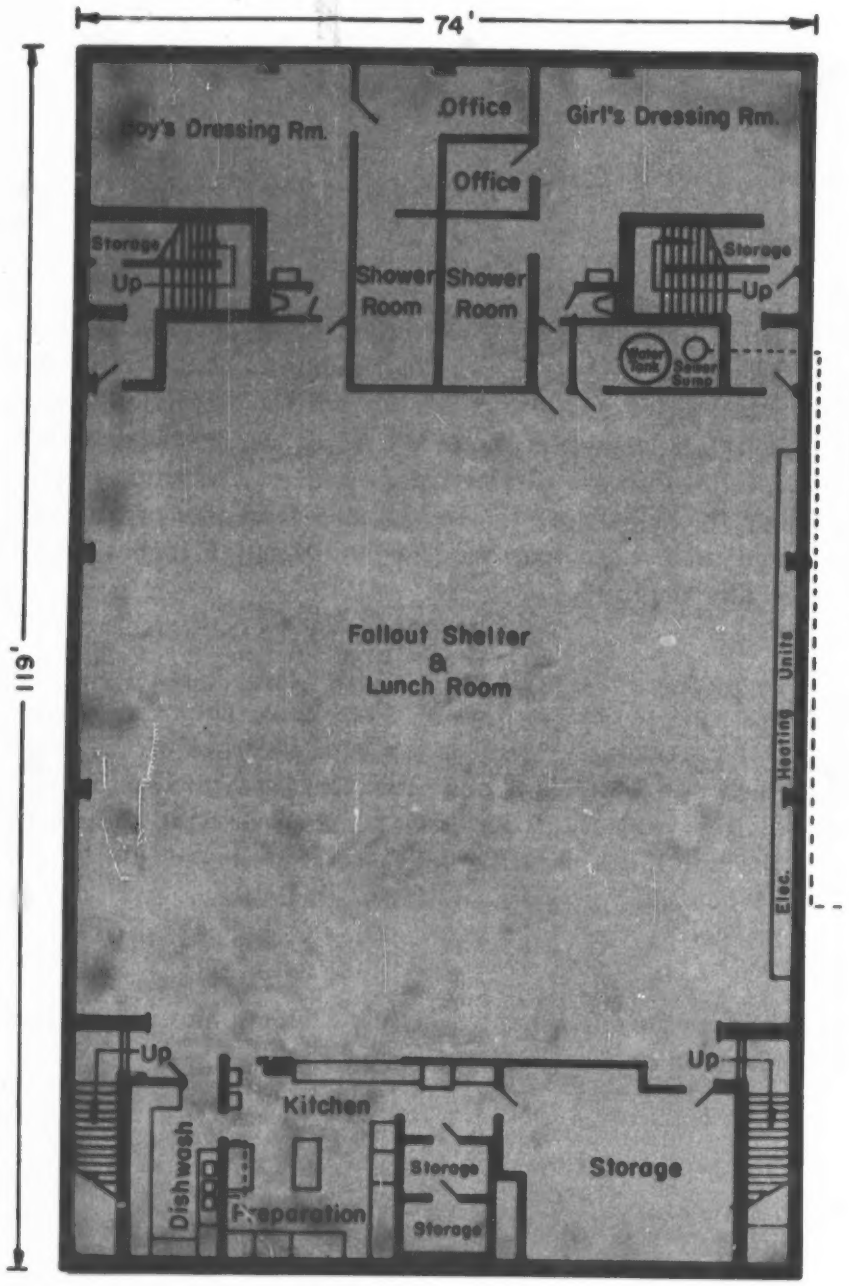
*Costs shown include shelter as well as 4,800 sq. ft. of additional school space obtained with new design.

North Central School, opened in September 1963, consolidated several rural area schools into a single structure. Currently, there are six bus routes taking students to and from the school. The 340 students presently enrolled are taught by 16 teachers.

The school would normally have been designed as a one-story slab-on-fill structure with a kitchen facility and limited lunchroom area above grade. In order to provide fallout shelter space serving a dual purpose, a decision was made to design the school with a basement facility. A shelter area having a capacity of 615 persons was incorporated into the lower level of the school which houses the cafeteria. In addition, boy's and girl's dressing rooms, showers, offices, storage and mechanical equipment rooms are also located on the lower level. Overhead protection is provided by a 10-inch reinforced concrete slab overlying the shelter area.

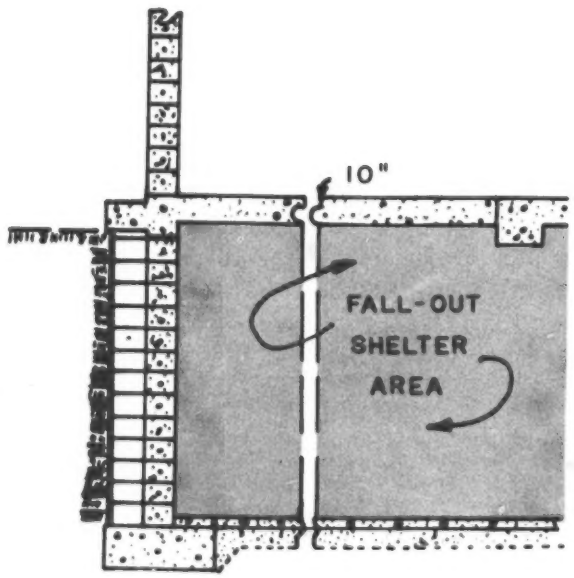
In designing the two-story school, the architect was able to provide a larger cafeteria area (4,800 sq. ft. of additional space) in the lower level which would not have otherwise been included in the original design. The difference in cost between the two school designs was estimated at $30,000. This cost included the concrete and excavation work to provide the fallout protection *as well as* the additional 4,800 sq. ft. of usable cafeteria space. The shelter area has additional dual use features such as kitchen with well stocked pantry, showers, water closets, and lavatories which are utilized in the physical education program.

The School Board's decision to accept the design incorporating shelter thus provided a larger dual purpose school facility which they ordinarily would not have had. They have provided a community service by making shelter space available for approximately 42 percent of the people residing in the school district.



Lower Level Plan

Section



Schools

Miami Coral Park Senior High School

Location: Miami, Fla.
Owner: Board of Public Instruction,
Dade County, Fla.
Architect-Engineer: Smith, Korach and Associates,
Miami, Fla.

Project Cost: $1,701,517

Gross Area: 132,414 sq. ft.

Cost per sq. ft.: $12.85

Shelter Area: 19,400 sq. ft.

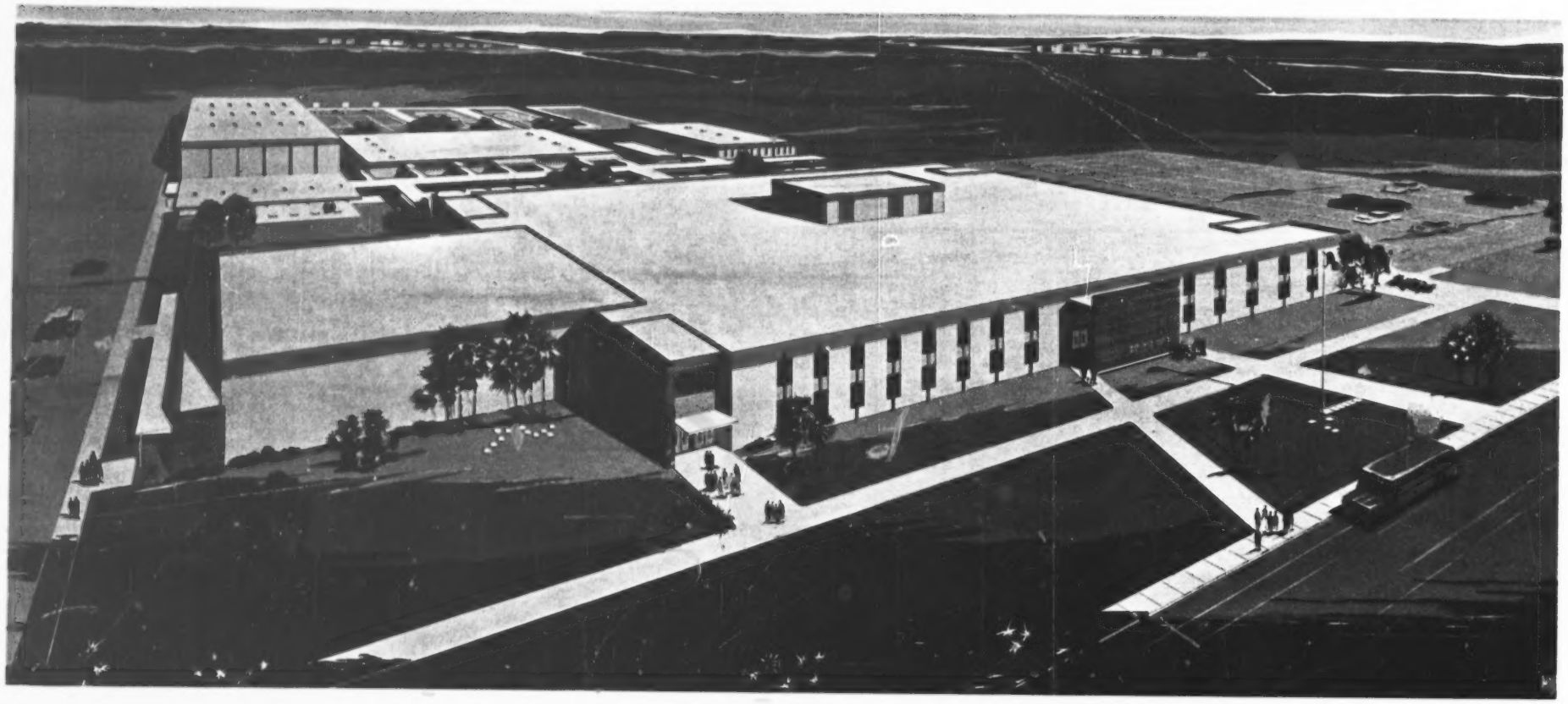
Shelter Cost:
General Construction: $33,000
Additional Equipment (mechanical, electrical, etc.): $8,000

Shelter General Construction Cost per sq. ft. of School Area: $0.25

This school is a two-story reinforced concrete structure all above-grade. The school is centrally air conditioned and has a minimum number of exterior windows. Shelter with a protection factor exceeding 100 is located in the core area of the first floor which consists of the library, administrative offices, and dining area. To provide the fallout protection, the slab thickness of the roof and second floor were increased an additional 2 inches above that normally required.

The central core is protected on all sides by corridors and classrooms. Of particular interest is the combined use of the brick wall at the south entrance as an architectural feature and to provide radiation protection. A field house located at the north side of the building limits the width of area that would be exposed to fallout and provides additional shielding.

The school has an enrollment of 1,705 students and can shelter 1,850 persons in an emergency.



Schools

West Dunbar Elementary School

Location: Miami, Fla.
Owner: Board of Public Instruction, Dade County, Fla.
Architect-Engineer: M. Tony Sherman & Associates, Miami, Fla.

Project Cost: $542,205

Gross Area: 49,729 sq. ft.

Cost per sq. ft.: $10.90.

Shelter Area: 10,000 sq. ft.

Shelter Cost:

General Construction: $15,000
Additional Equipment (mechanical, electrical, etc.): $10,000

Shelter General Construction Cost per sq. ft. of School Area: $0.30

The building is a two-story, reinforced concrete aboveground structure with the shelter area in a first-floor core area. The primary shelter area serves as an auditorium and cafeteria for the school. Kitchen, library, and administrative office adjoin the cafeteria area and also serve as shelter area although at a lower protection factor. Classrooms are located on either side of the core.

The shelter area is provided with emergency air supply ducts built into the walls. Emergency ventilation fans are available and can be connected into the ducts. An emergency well has also been provided

The building is air-conditioned and the number of windows in the exterior classrooms has been minimized for economical operation. The entrances on the north and south ends of the school have been baffled to improve the shielding. Building walls are of block construction with sand filled cores.

The school has a student population of 800 and can accommodate up to 1,000 shelter occupants at protection factors varying from 40 to 90.

Exterior View

Cafeteria – Shelter Area

School Shelter Cost Summary

	Cascade Junior High School,	*Bemus Point Junior-Senior High School,*	*Lincoln Elementary School,*	*United High School,*	*Miami Coral Park Senior High School,*	*Miami Carol City Senior High School,*
Location	*Longview, Wash.*	*Chautauqua County, N.Y.*	*Alva, Okla.*	*Laredo, Tex.*	*Miami, Fla.*	*Miami, Fla.*
Project Cost	$1,405,588	$1,897,551	$201,000	$704,000	$1,701,517	$1,638,508
Gross Area (sq. ft.)	90,423	116,000	16,500	68,000	132,414	136,000
Cost per sq. ft.	$15.54	$16.36	$12.12	$10.35	$12.85	$12.05
Shelter Area (sq. ft.)	18,000	11,000	2,565	29,000	19,400	21,300
Shelter Cost: General Construction	$15,000	$17,500	$5,130	$20,520	$33,000	$7,900
Additional Equipment (Ventilation, Electric and Plumbing)	$18,000	$7,500	0	$32,346	$8,000	$19,500
Shelter Cost (including equipment) per sq. ft. of shelter space	$1.83	$2.27	$2.00	$1.82	$2.11	$1.29
Shelter General Construction Cost per sq. ft. of shelter space	$0.83	$1.68	$2.00	$0.71	$1.69	$0.37
Shelter General Construction Cost per sq. ft. of gross school area	$0.17	$0.15	$0.31	$0.30	$0.25	$0.06
School Capacity	850	1,000	165	540	1,705	1,400
Shelter Capacity	1,800	1,100	256	2,000	1,850	1,750

West Dunbar Elementary School,	*William Floyd Junior-Senior High School,*	*Union Park, Robinswood and Carver Junior High School,*	*Mayville High School,*	*Park Junior High School,*	*Glades Junior High School,*	*Goddard Senior High School,*	*North Central School,*
Miami, Fla.	***Shirley, L.I., N.Y.***	***Orlando, Fla.***	***Mayville, Wis.***	***Artesia, N. Mex.***	***Miami, Fla.***	***Roswell, N. Mex.***	***Rogers, N. Dak.***
$542,205	$3,719,000	$1,316,000	$1,464,800	$1,111,147	$1,132,300	$1,944,070	$468,000
49,729	183,082	79,275	111,686	95,623	96,882	186,273	43,000
$10.90	$20.42	$16.60	$13.10	$11.61	$11.69	$10.42	$10.88
10,000	22,566	29,640	7,600	34,126	14,720	82,273	6,500
$15,000	$5,000	$46,460	$14,000	$10,000	$6,680	$13,000	$30,000*
$10,000	$36,000	0	$4,000	$49,200	$11,720	$117,000	0
$2.50	$1.82	$1.57	$2.37	$1.74	$1.25	$1.58	$4.62*
$1.50	$0.22	$1.57	$1.84	$0.29	$0.45	$0.16	$1.38
$0.30	$0.03	$0.59	$0.13	$0.10	$0.07	$0.07	$0.21
800	1,550	1,800	560	1,000	1,200	2,000	356
1,000	1,761	2,964	760	2,275	1,472	6,500	615

*Cost of providing shelter plus 4,800 sq. ft. of additional school space. Estimate of general construction cost only is $9,000.

Other Structures

Arlington County Fire Division

Office Building & Fire Station No. 4

Location: 10th and North Hudson Streets, Arlington, Va.

Owner: County of Arlington, Virginia

Architect-Engineer: H. D. Nottingham & Associates, Arlington, Va.

Total Cost: $460,000

Gross Area: 24,744 sq. ft.

Shelter Area: 1,100 sq. ft.

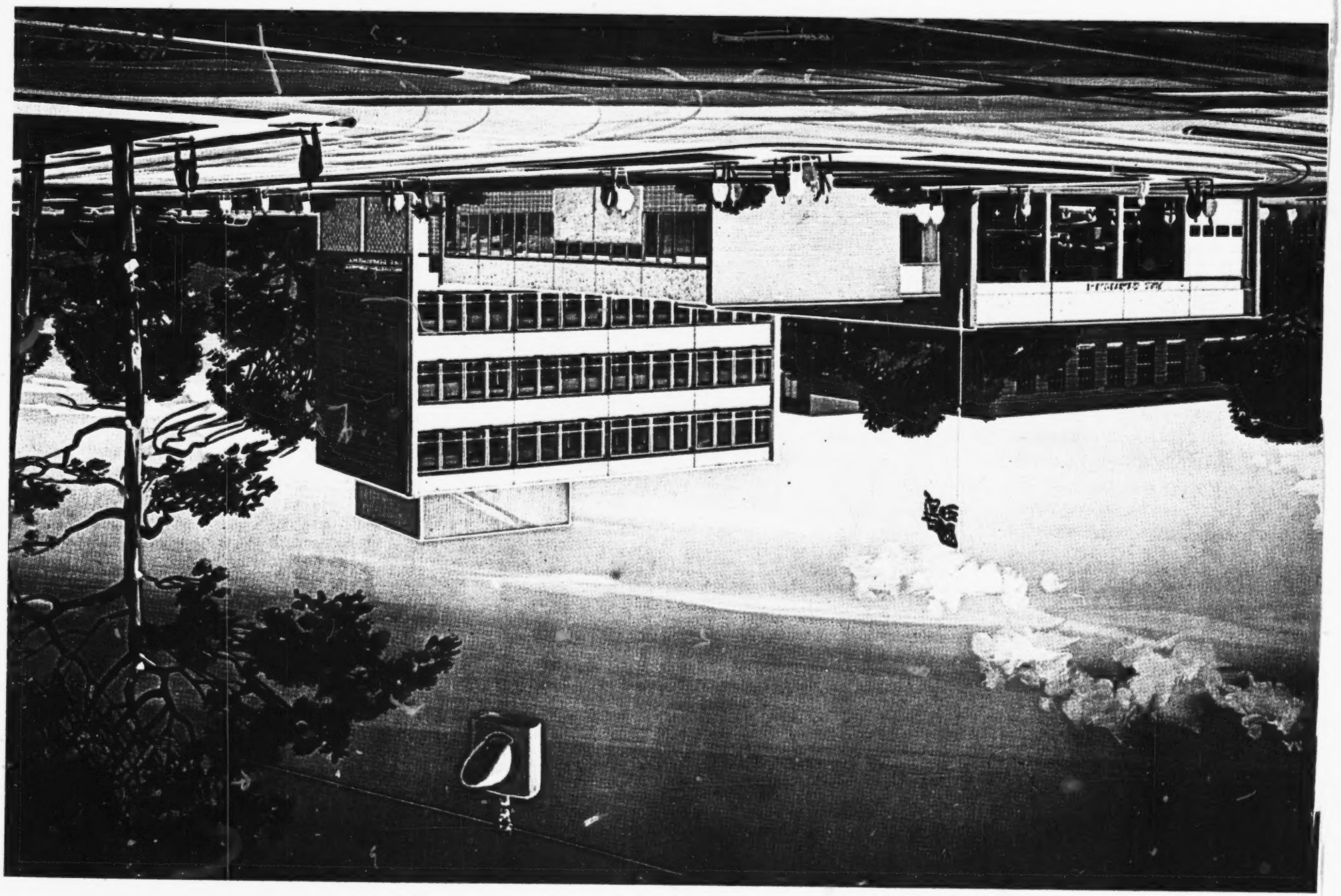
Shelter Cost: None—inherent in basic design

Protection Factor: In excess of 100

This structure was designed as a four-story, reinforced concrete combination office building and fire station.

The belowgrade basement, containing a photolab, fire company storage room, mechanical equipment and telephone vaults, also serves as a fallout shelter area.

The structure contains mechanical ventilation equipment. The shelter area is inherent in the basic design of the building.



Other Structures

69th Precinct Station House

Location: **Rockaway and Foster Avenues, Brooklyn, N.Y.**

Owner: **Police Department, City of New York**

Architect: **Knappe and Johnson,* Scarsdale, N.Y.**

Structural Engineers: **Fromme & Vosganian, New York, N.Y.**

Mechanical Engineer: **Herman Scherr, New York, N.Y.**

Shelter Analyst: **Nathaniel Firestone, New York, N.Y.**

Total Cost: **$882,000**

Gross Area: **27,000 sq. ft.**

Cost per sq. ft.: **$32.60**

Shelter Area: **1,500 sq. ft.**

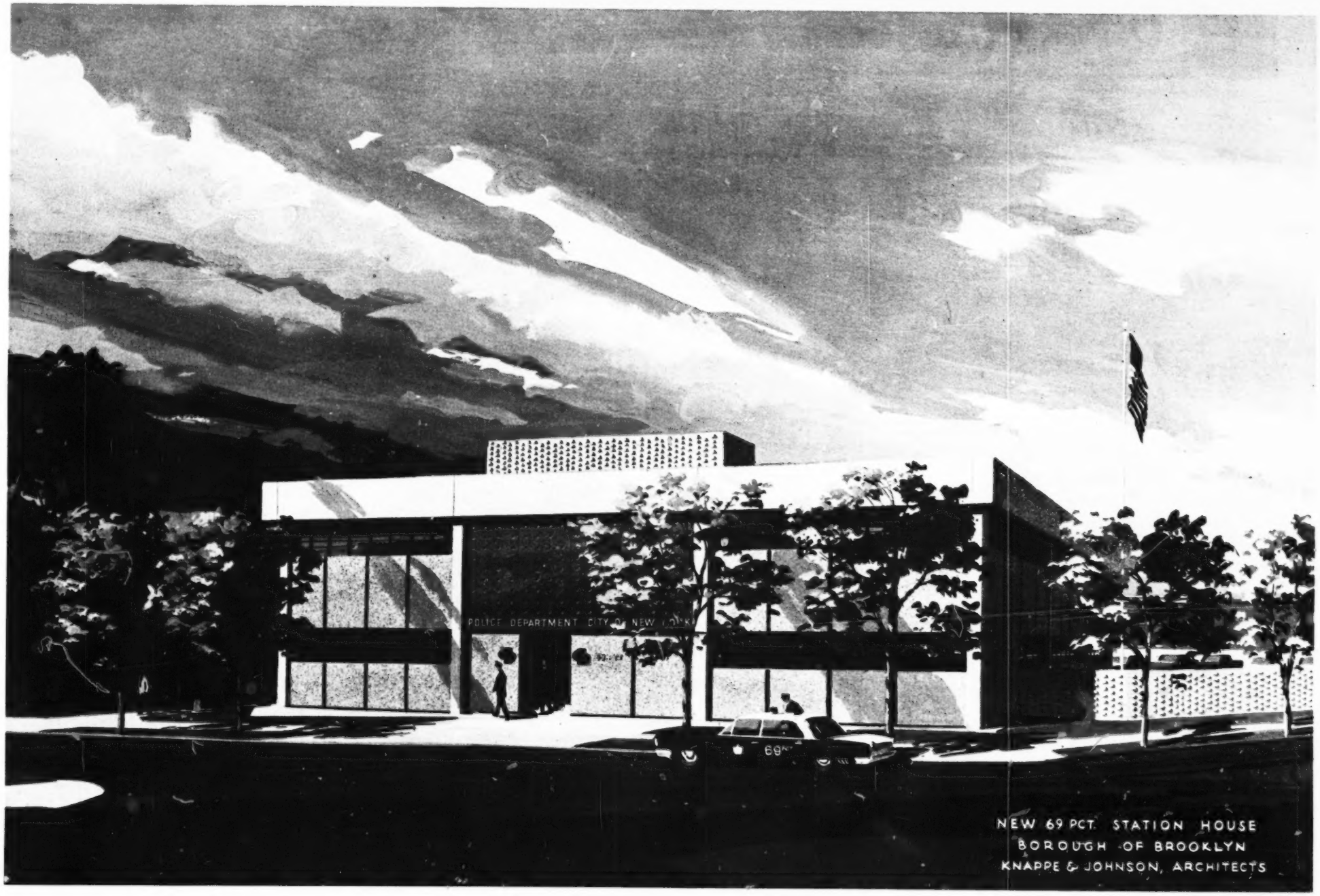
Shelter Cost: **Unknown**

Protection Factor: **100**

The new 69th Precinct Station House is a two-story, reinforced concrete building with a basement. Included in the basement are a records room, locker room, lecture room, pistol range, radio equipment, and storage areas. Shelter for 150 persons is located in the lecture, general storage, and housekeeping supply rooms in the basement area.

Three 500-gallon water storage tanks, adjacent to the shelter area, will provide an emergency water supply. Provisions have been made for the incorporation of an emergency generator to operate the ventilation system in an emergency.

***Designed and constructed under the supervision of the Department of Public Works, City of New York, Bradford N. Clark, Commissioner.**



NEW 69 PCT. STATION HOUSE
BOROUGH OF BROOKLYN
KNAPPE & JOHNSON, ARCHITECTS

Other Structures

Administration Building for School District of the City of Pontiac

Location: Pontiac, Mich.

Architect: Eberle M. Smith Associates, Detroit, Mich.

Project Cost: $540,994

Gross Area: 24,564 sq. ft.

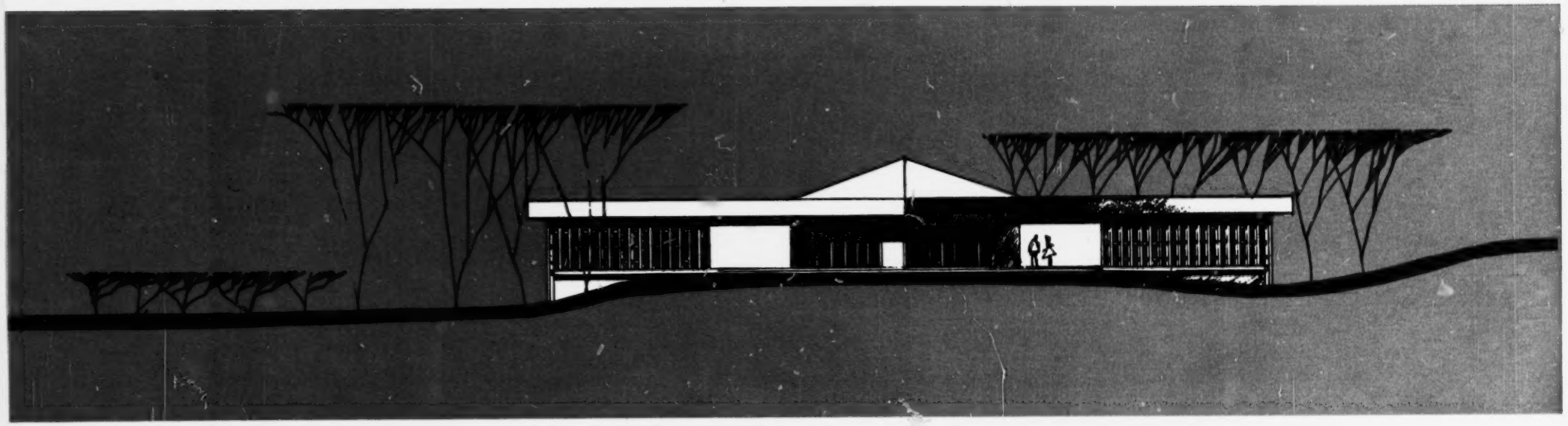
Cost per sq. ft.: $22.02

Shelter Area: 1,200 sq. ft.

Shelter Cost: None—inherent in basic design

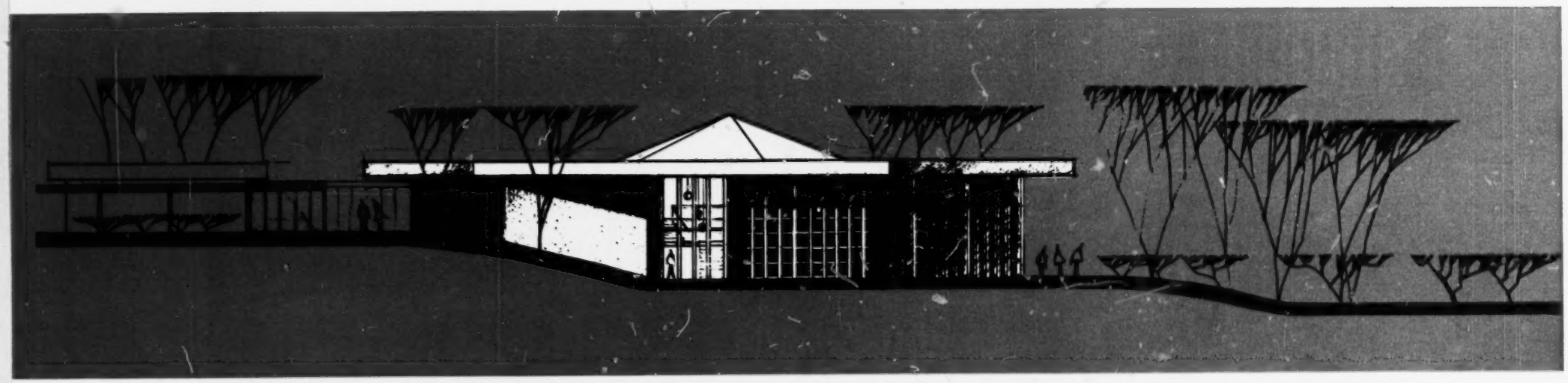
Protection Factor: 40

The adminstration building was completed in 1964. Topography of the site dictated a two-story plan with entry to the upper floor at grade level on the east, and entry to the lower floor on grade level on the south and west. The building is a compact, six-sided structure with reinforced concrete exterior walls and roof. The shelter area is located in the center (workshop and storage area) of the lower-level floor. The design illustrates the use of core shelter, and takes advantage of the site conditions to provide additional protection.

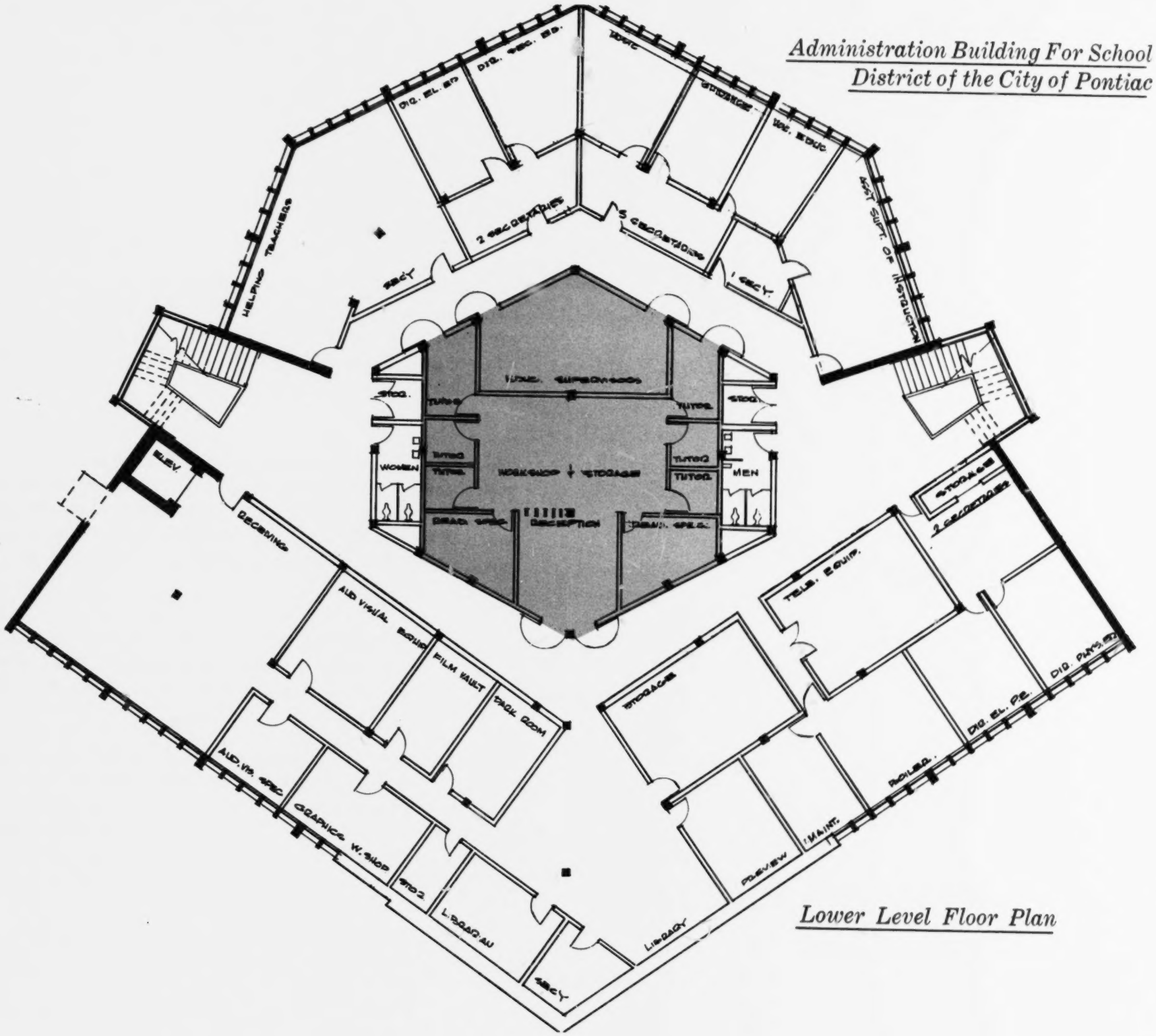


Entry Elevation

Elevation



Administration Building For School District of the City of Pontiac



Lower Level Floor Plan

Other Structures

Fire Station

Location: Pine Street and Rincon Avenue, Livermore, Calif.

Owner: City of Livermore, California

Architect: Frederick J. Schlaepfer, A1A,
Mason and Associates,
San Jose, Calif.

Structural Engineer:
Earl E. Mason,
Livermore, Calif.

Project Cost: $130,000

Gross Area: 6,523 sq. ft.

Cost per sq. ft.: $19.93

Shelter Area: 3,043 sq. ft.

Shelter Cost: $85,000* (For Emergency Operating Center)

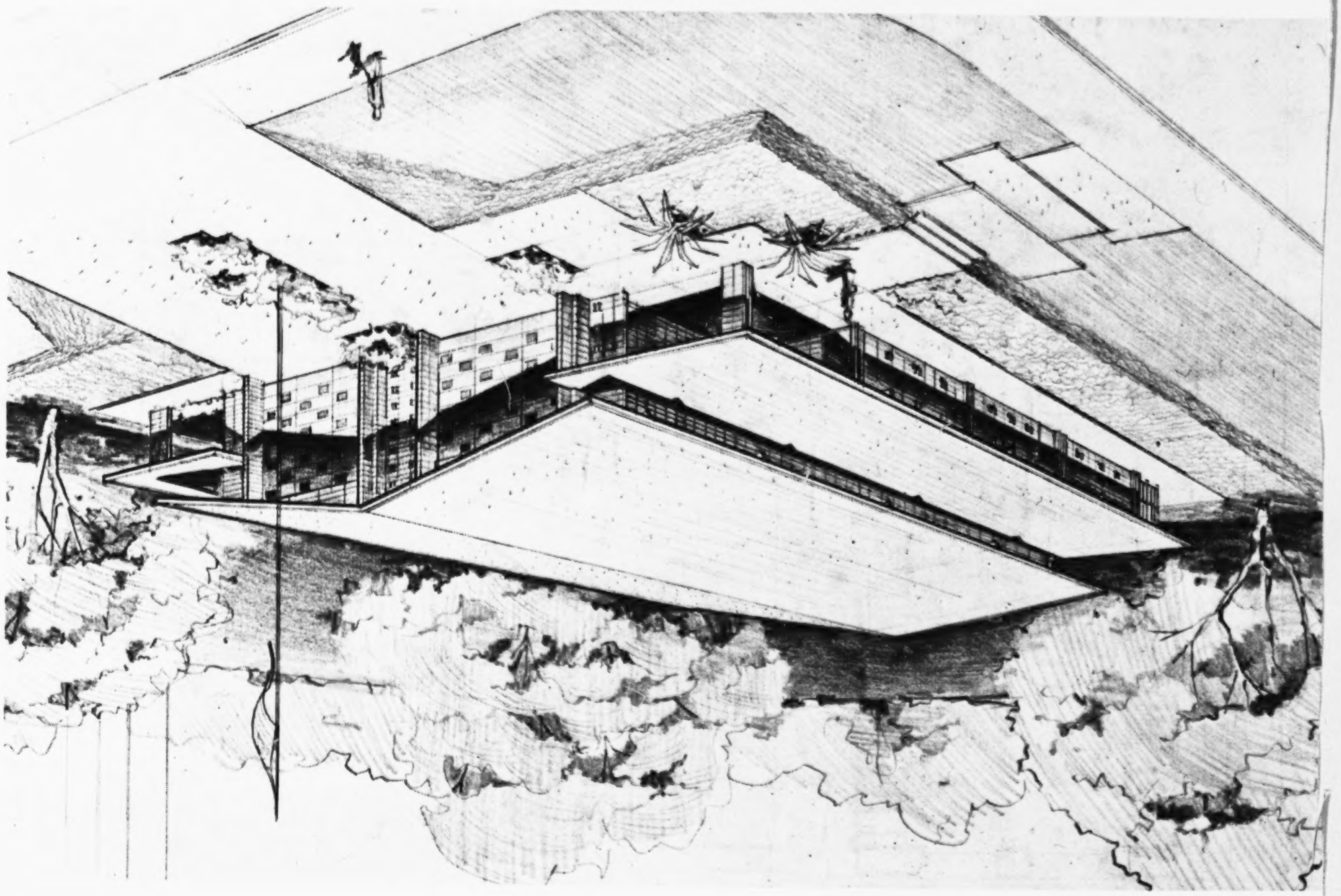
*Cost for providing only the additional shielding for fallout protection PF 1,000 was $6,000 or $0.92 per sq. ft. of gross area.

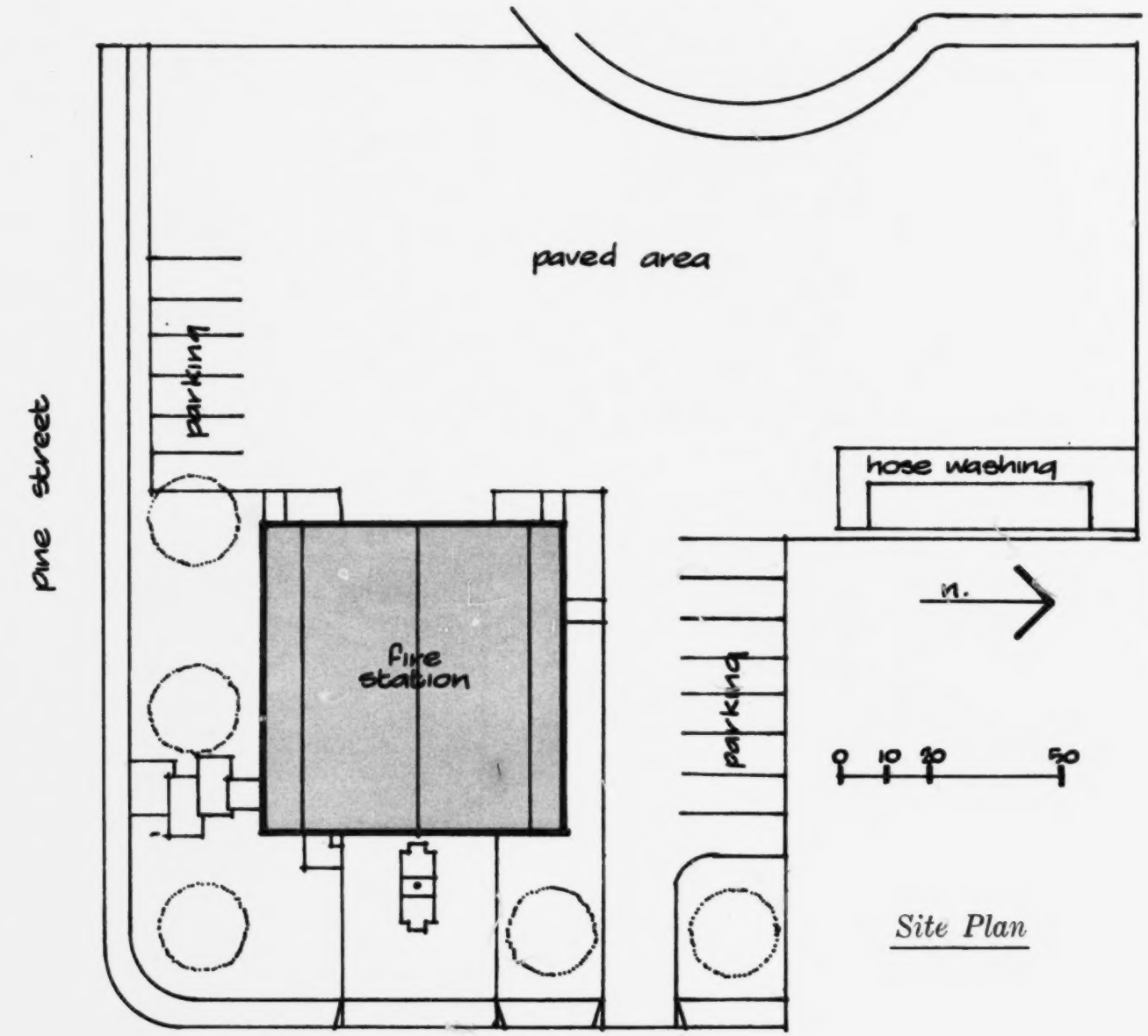
In 1963, the City Council of Livermore, Calif. elected to incorporate an emergency operating center in the design of its new fire station. All of the usual quarters commonly associated with and required for fire department operations have been included in the basement area of the fire station.

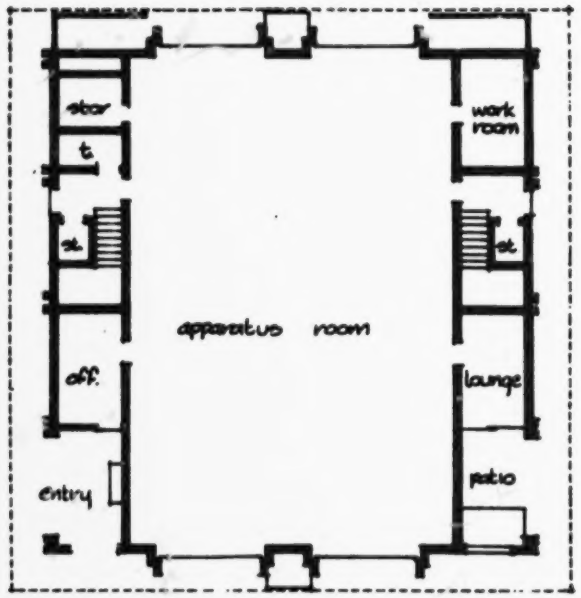
The building is of concrete block construction with the downstairs portion covered by a two-foot thick reinforced concrete slab. This serves as the floor for the engines and also provides much of the overhead protection to the shelter area in the basement. A protection factor of 1,000 is provided.

For fire department needs, the structure will house four engine companies. A complete radio-communication base network is installed with a 70-foot antenna tower for police, fire, and civil defense operations.

While the structure depicted serves as an emergency operating center, the design is such that it provides inherrent fallout protection to the basement area. In designs of this type the use of a reinforced concrete floor (7 inches or more thick to support fire fighting equipment) will usually always provide suitable shelter to the basement area below at no increase in construction cost.



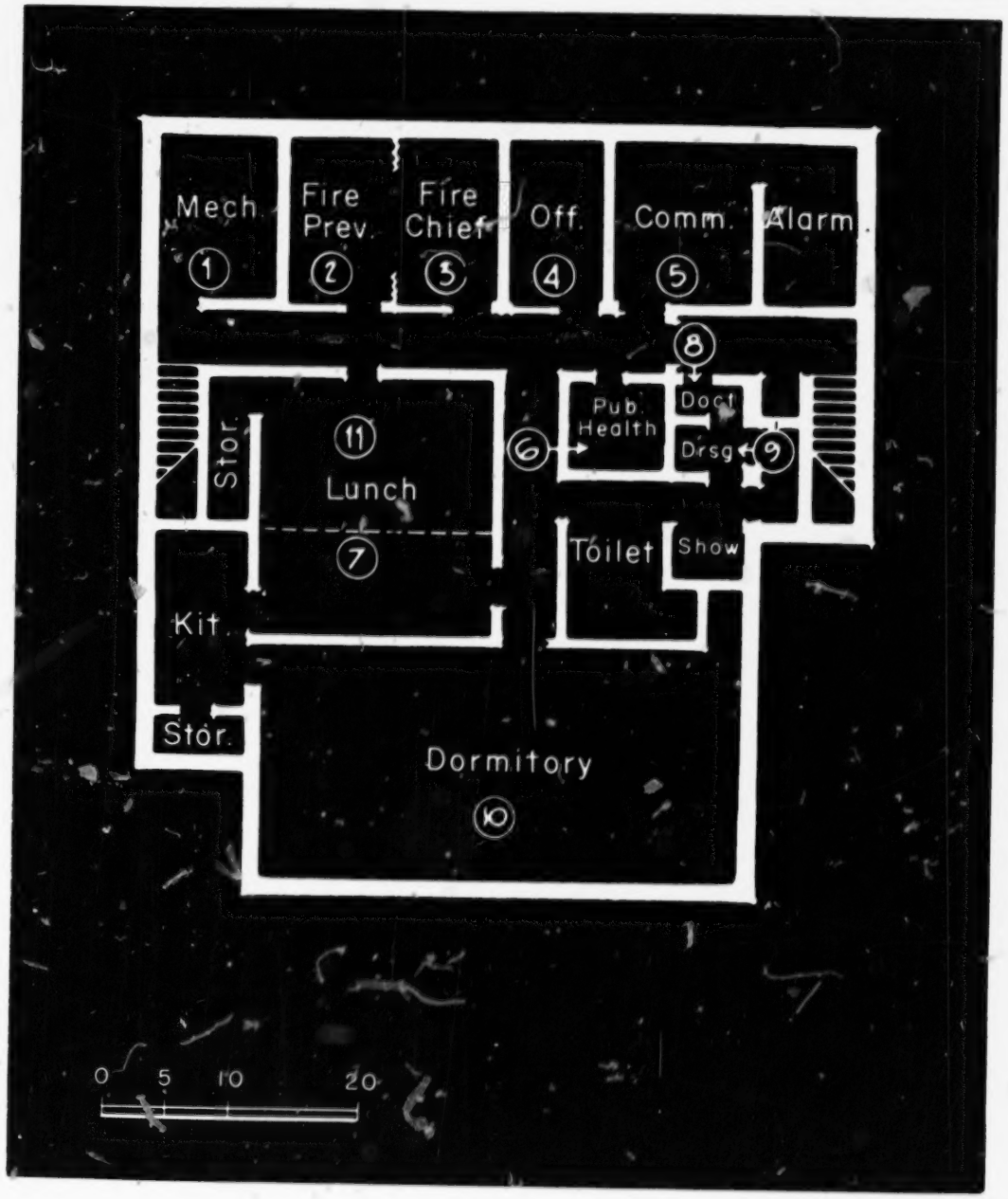




Ground Floor Plan

Site Plan

Basement Plan



E.O.C. Functions

1 *Mechanical & Emergency Power*
2 *Eng. Util. & Transp., Conserv. & Manpower, Supply & Resources 3/3*
3 *Director & Asst. Director of Staff 2/2*
4 *Emergency Welfare & Medical 3/2*
5 *Emergency Communications & Warning 3/3*
6 *Isolation*
7 *Weapons Effect (C.B.R.) 2/2*
8 *Decontamination*
9 *Dressing Room*
10 *Second Shift 16/24*
11 *Operations, Law Enf., Fire & Rescue, Conference (Em. City Gov't.) 8/4*

Other Structures

Administration Wing Maintenance

Control Building

Location: Nellis Air Force Base, Las Vegas, Nev.

Owner: U.S. Air Force

Mechanical-Electrical Engineer:
d'Autremont-Helms and Assoc.

Associate Architect:
Jose Y. Almanza,
Los Angeles, Calif.

Structural Engineer:
Robert L. Culp,
Los Angeles, Calif.

Shelter Analysts:
Joseph & Joseph Architects-Engineers,
Los Angeles, Calif.

Project Cost: $470,000 (including outside utilities)

Gross Area: 22,080 sq. ft.

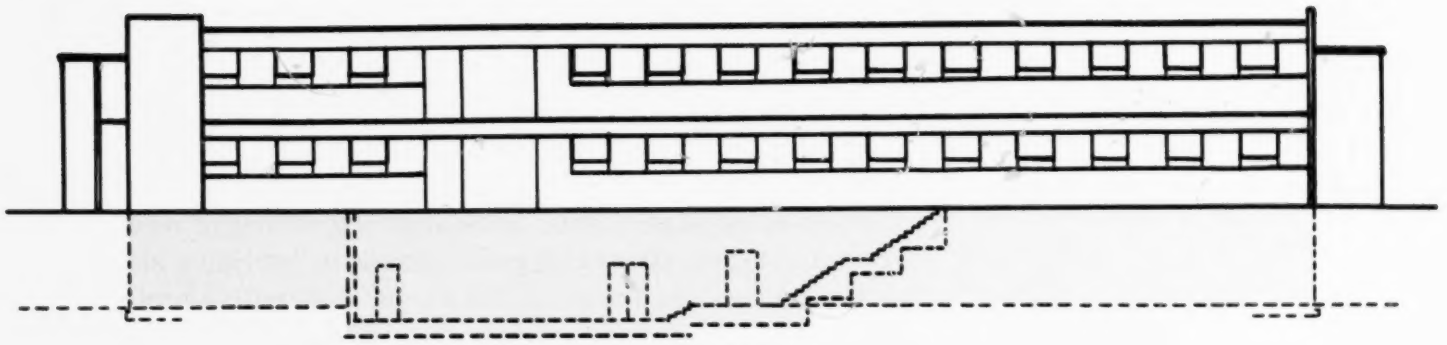
Cost per sq. ft.: $21.29

Shelter Area: 6,210 sq. ft.

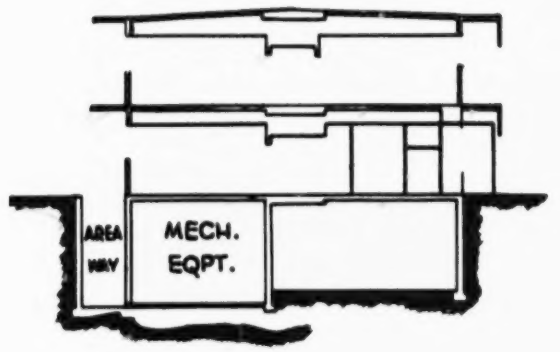
Shelter Cost: none

The building basically is a reinforced concrete structure with brick exterior walls in many places abovegrade. Concrete sun protection "eyebrows" have been provided above both the front and back rows of strip windows. The structure has two stories abovegrade and one floor belowgrade which were designed and constructed for the primary use of the building. The basement area provides shelter protection as an added feature.

An outside entrance to the basement area on the north side of the building was provided by using a stairway and an areaway. Protection was enhanced by reversing the stairway from the first floor to the basement and by making the stairway concrete instead of steel. The mass thickness of the wall around the mechanical equipment room was increased and an emergency supply storage area under a stairway at the south end was provided. Practically the entire basement area can be used for shelter with some areas having a protection factor exceeding 200.



Elevation



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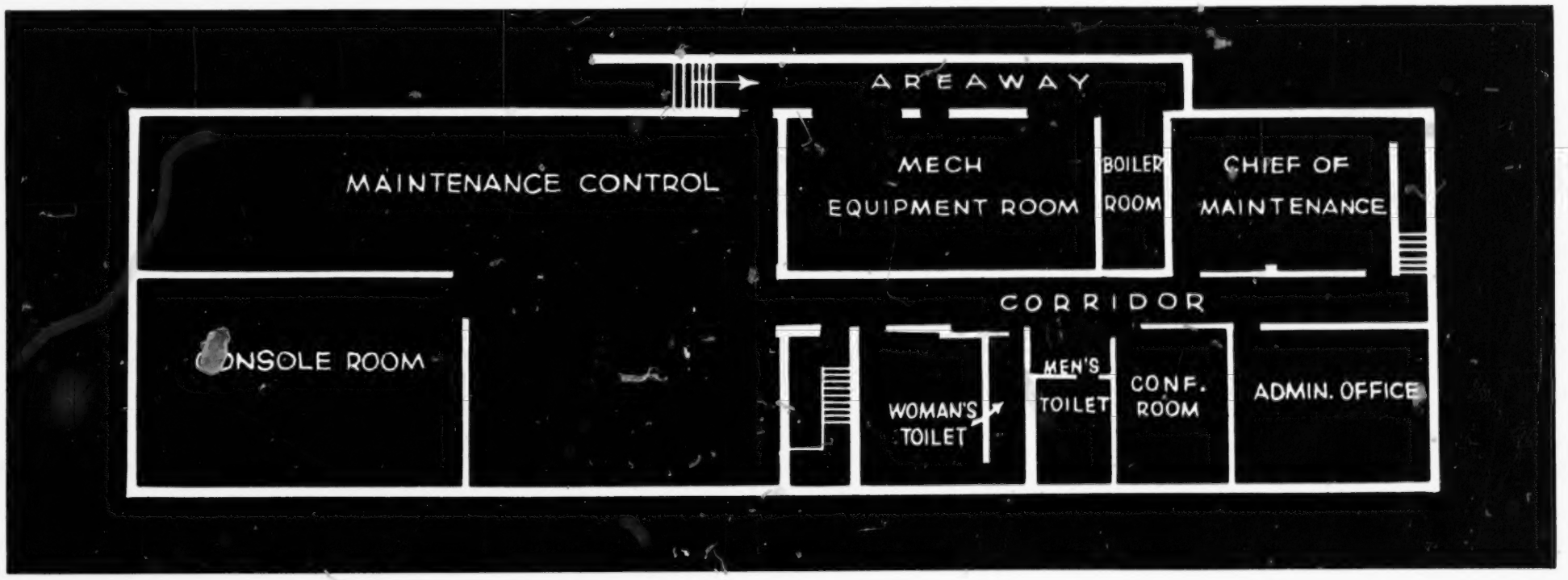


Floor Plan

Other Structures

Bucks County Emergency Operating Center

Location: Court House,
Doylestown, Pa.

Owner: Bucks County, Pa.

Engineer: Walter F. Spiegel,
Jenkintown, Pa.

Total Cost: $71,832.60 (for providing EOC)*

Shelter Area: Approximately 6,000 sq. ft. in Emergency Operating Center

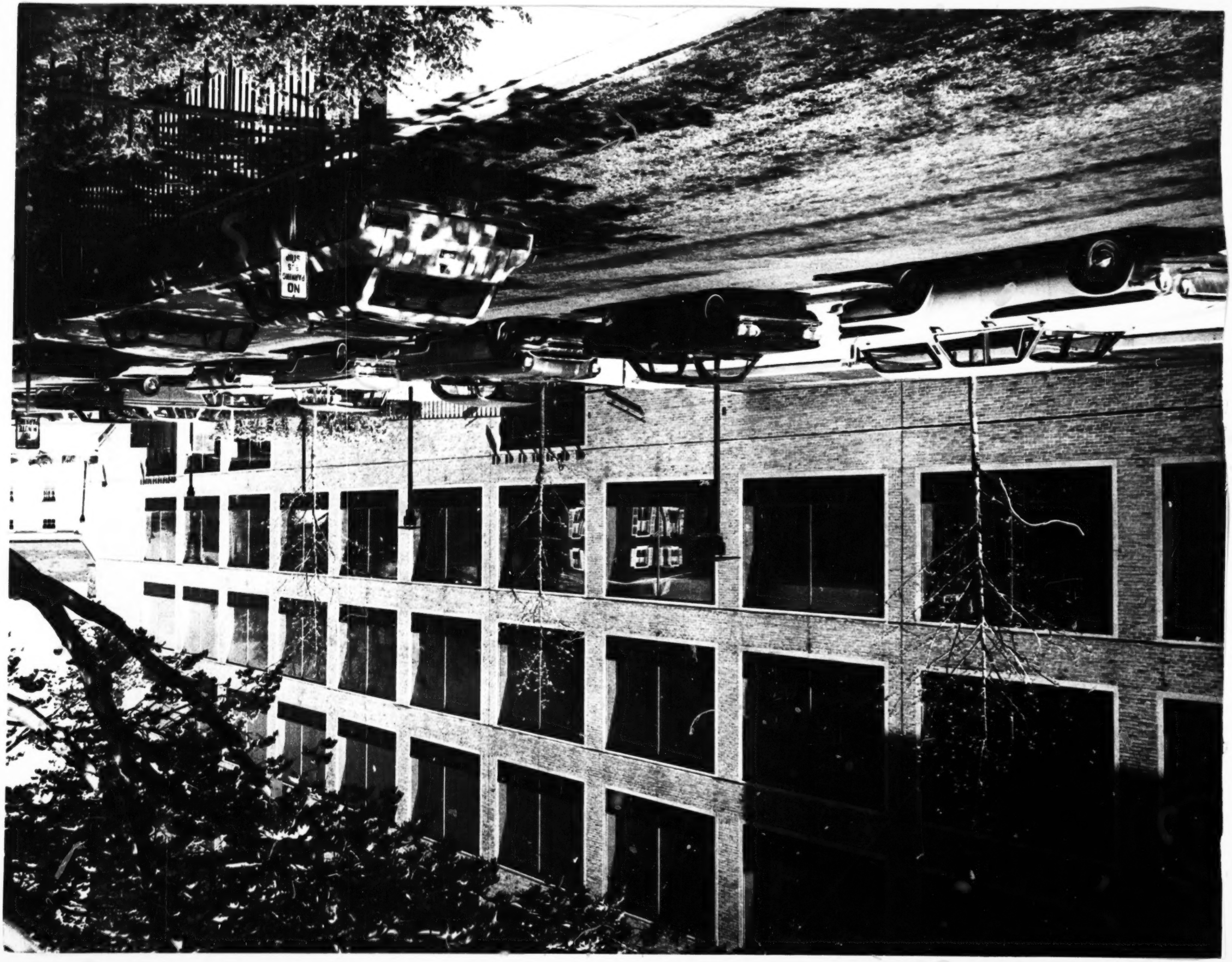
*Cost for providing the additional shielding only was approximately $11,800 or $1.97 per sq. ft. of shelter space. If a protection factor of only 100 had been provided shielding cost would have been reduced to approximately $3,000.

The administration building of the Bucks County Court House is a seven-story, steel frame, brick-sheathed structure which required only minor structural modifications to provide a shielded emergency operating center on the ground floor with a protection factor of 500. Additional wall mass thickness was added to the walls surrounding the EOC.

As one walks into the ground floor of the Court House, it is difficult to visualize that a major portion of the space will serve as an emergency operating center during a disaster period. One may see a jury panel confined in the jury room, the normal milling of people in the hallway, and other building functions going on as usual.

In event of an emergency, the jury room will be rearranged and the space will serve to house local government operation with its attendent auxilliary disaster functions. The storage spaces in the hallway will become the message nerve center of the county, bunks stored in the storage cribs will be set up to make domitories in the locker rooms, and the kitchen facility now used by the maintenance personnel will become a food preparation center.

Habitability for emergency center staff has been improved by forced air ventilation. Drinking water and equipment cooling rquirements are supplied by a deep well. The emergency communication center will contain remote controlled radios: police, fire, and RACES, plus radio teletype. Two 50-kw emergency generators are also included. Costs for incorporating the mechanical, electrical, and water supply systems amounted to $54,974.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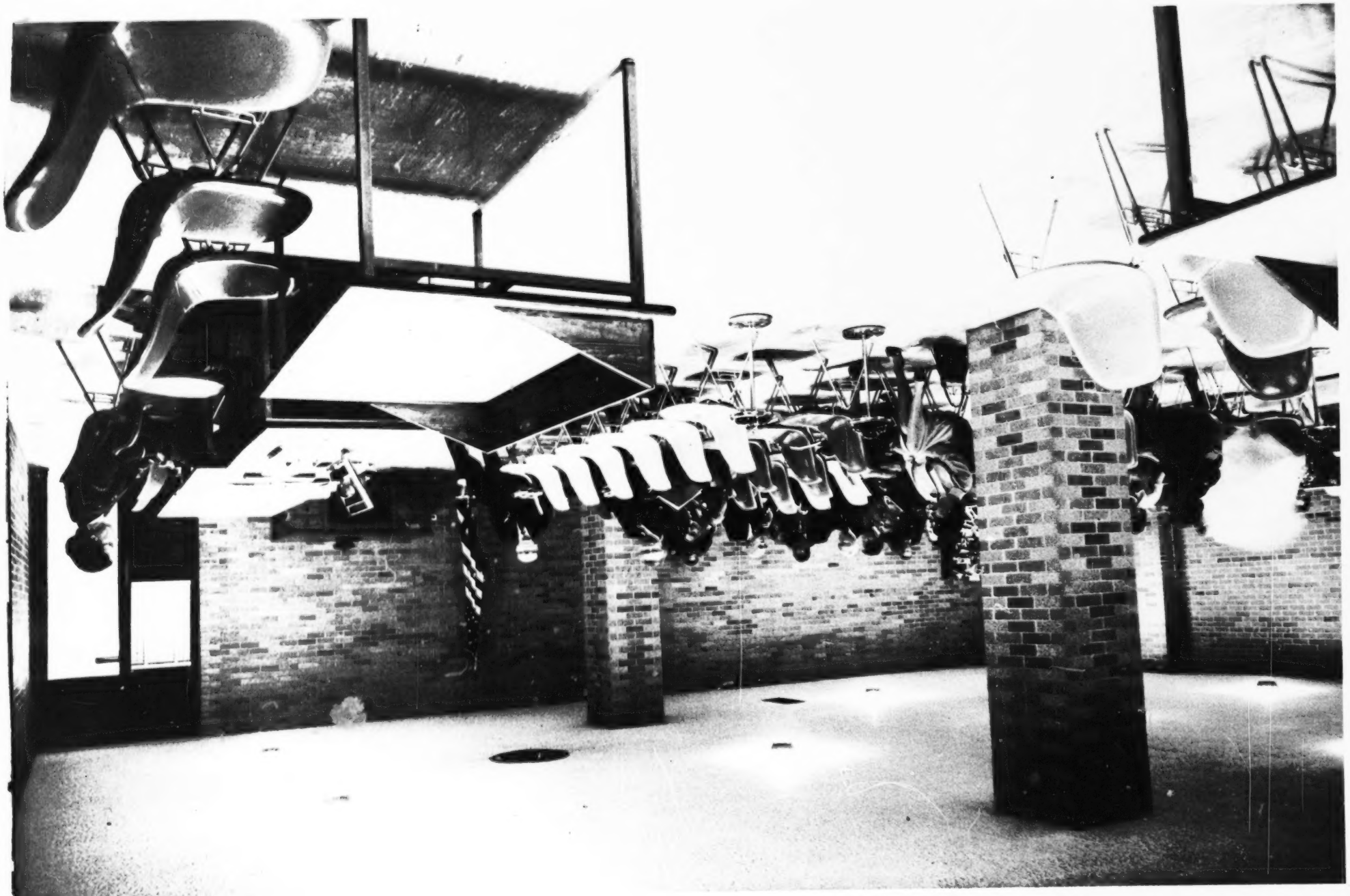
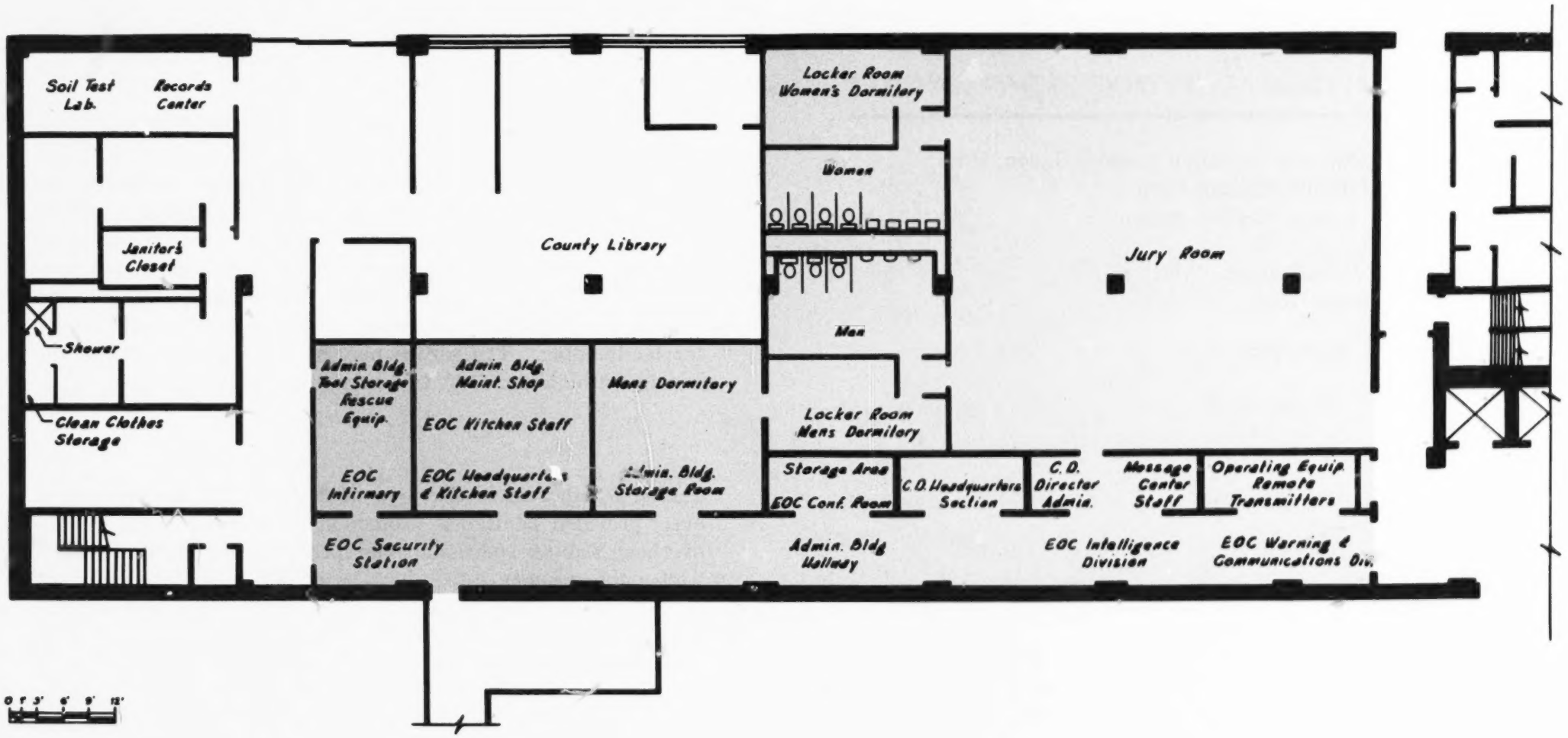



Soil Test Lab.
Records Center
Janitor's Closet
Shower
Clean Clothes Storage
County Library
Admin. Bldg. Tool Storage Rescue Equip.
Admin. Bldg. Maint. Shop
EOC Kitchen Staff
EOC Infirmary
EOC Headquarters & Kitchen Staff
Mens Dormitory
Admin. Bldg. Storage Room
Locker Room Women's Dormitory
Women
Men
Locker Room Mens Dormitory
Jury Room
Storage Area
EOC Conf. Room
C.D. Headquarters Section
C.D. Director Admin.
Message Center Staff
Operating Equip. Remote Transmitters
EOC Security Station
Admin. Bldg Hallway
EOC Intelligence Division
EOC Warning & Communications Div.
0' 3' 6' 9' 12'

Floor Plan

Other Structures

Mt. Ogden Terrace Apartments

Location: 29th and Buchanan Avenue, Ogden, Utah
Owner: Mt. Ogden Terrace Corp.
Architect: Arthur Mueller, A1A,
Ogden, Utah
Engineer: John O. Reeve, P.E.,
Ogden, Utah

Total Cost: $1,250,000

Gross Area: 104,421 sq. ft.

Cost per sq. ft.: $11.97

Shelter Area: 16,912 sq. ft.

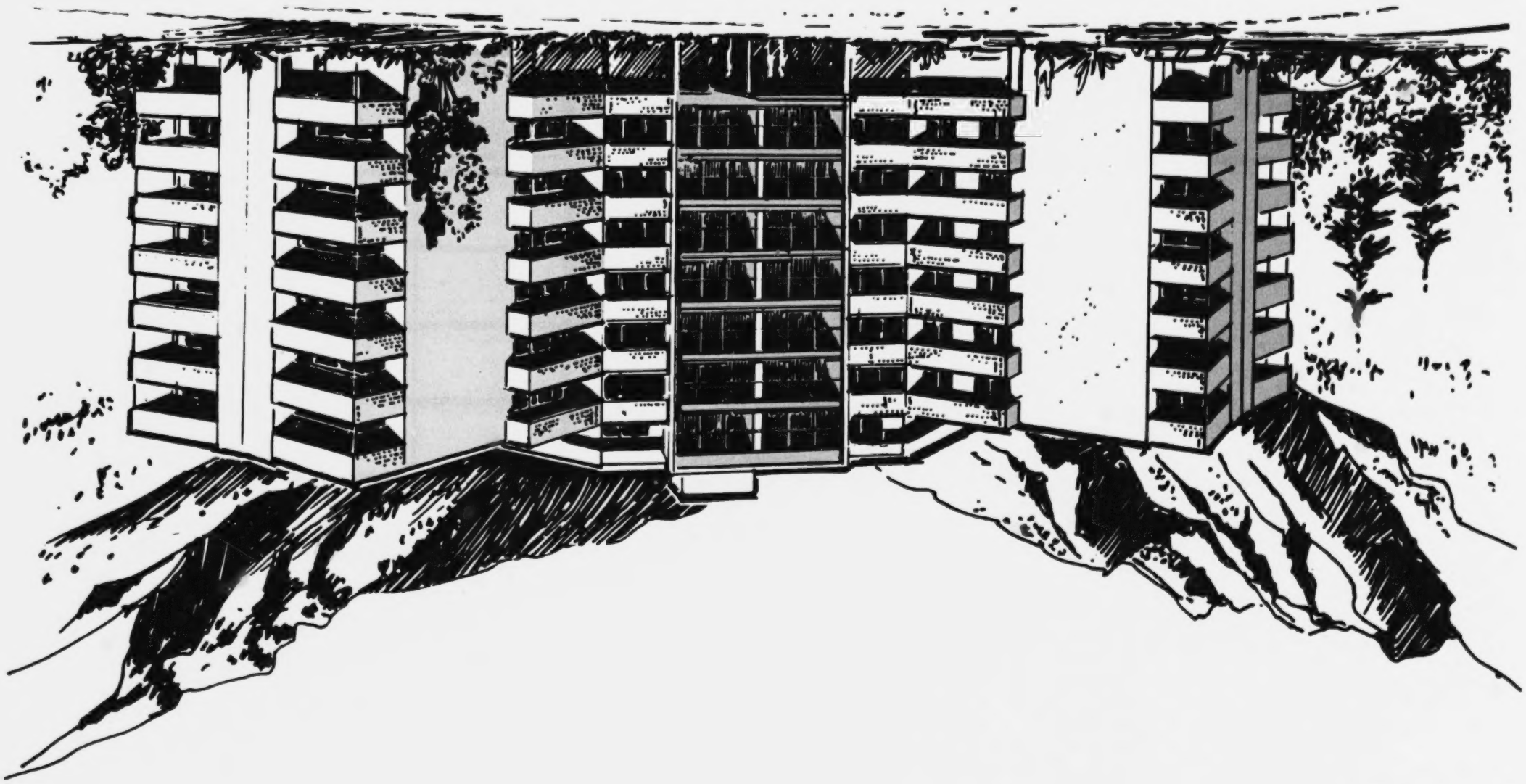
Shelter Cost: $3,000*

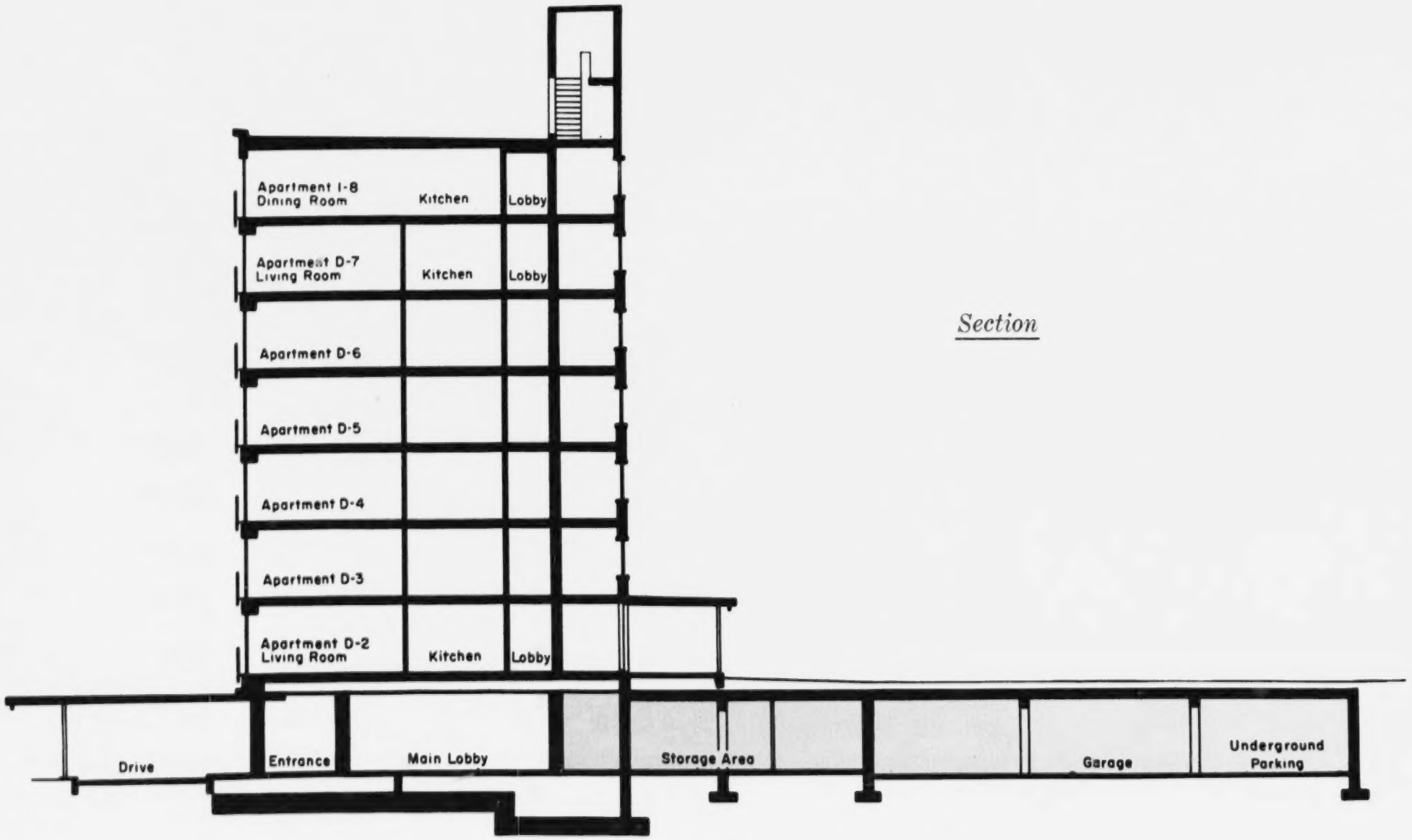
Shelter Cost per sq. ft. of Gross Area: $0.03*

The Mt. Ogden Terrace Cooperative Apartments are located in an eight-story aboveground structure with an adjoining underground parking garage. A total of 50 apartments are included in the structure. An exceptionally high degree of fallout protection is located in the garage area. This protection is provided by means of a 12-inch overhead concrete slab with an earth cover for landscaping. The garage may be entered from within the apartment building, or by two outside curved ramps.

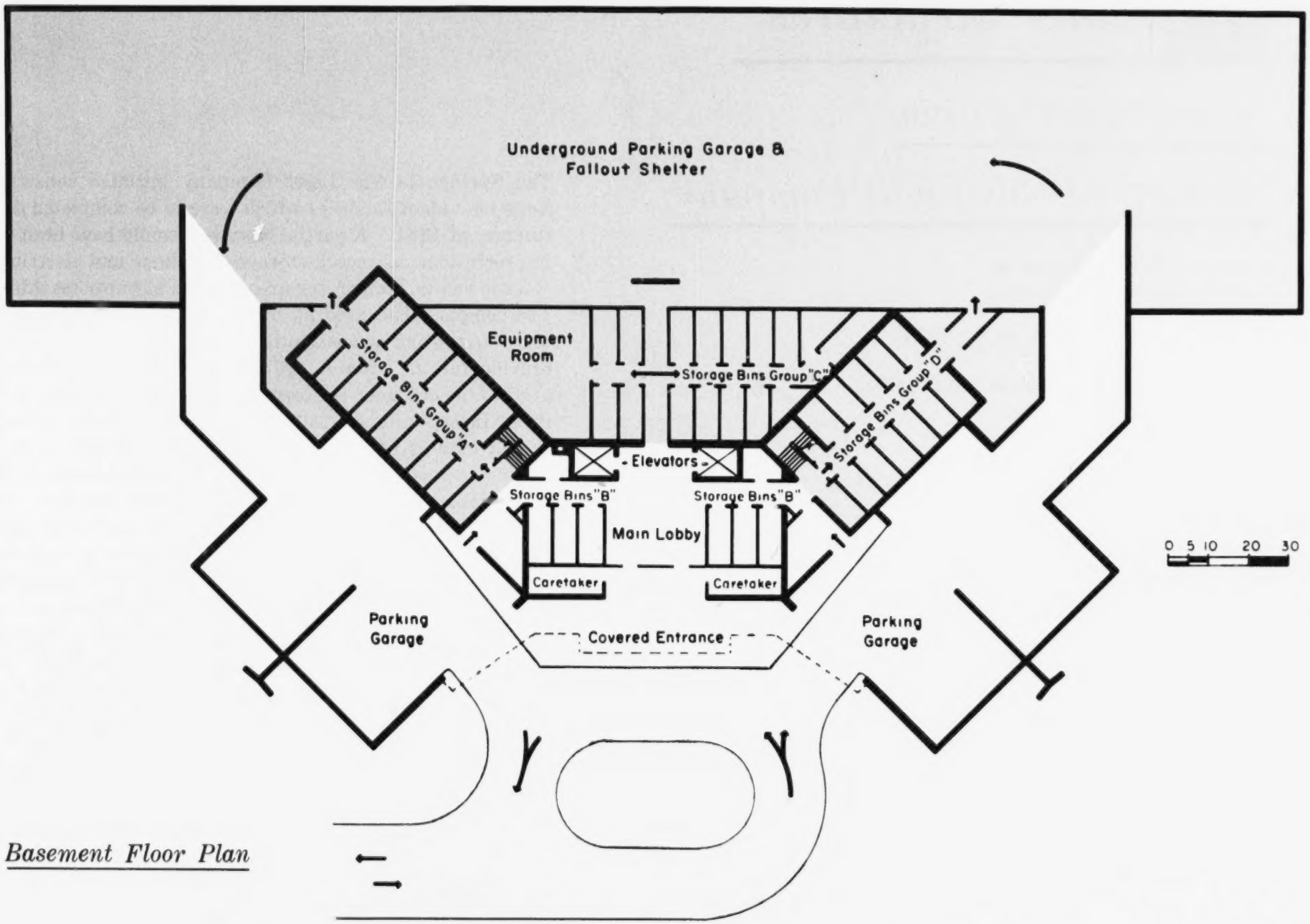
Shelter is inherent in this type of design. The designer, however, provided additional protection by increasing the garage overhead slab an additional four inches and by incorporating a baffled entranceway.

*Cost for providing mass shielding only to obtain a protection factor of 1750. A lower protection factor (PF 350) could have been provided at no increase in cost.




Apartment 1-8
Dining Room
Kitchen
Lobby
Apartment D-7
Living Room
Kitchen
Lobby
Apartment D-6
Apartment D-5
Apartment D-4
Apartment D-3
Apartment D-2
Living Room
Kitchen
Lobby
Drive
Entrance
Main Lobby
Storage Area
Garage
Underground
Parking

Section



Basement Floor Plan

Other Structures

New Plant Facilities

Springfield Gas Light Company

Location: Roosevelt Avenue,
Springfield, Mass.

Owner: Springfield Gas Light Company

Architect-Engineer: Munson & Mallis, Inc.,
Springfield, Mass.

Shelter Analyst:
A. George Mallis & George T. Klotsas,
Springfield, Mass.

Project Cost: $1,700,000

Gross Area: 153,700 sq. ft.

Cost per sq. ft.: $11.06

Shelter Area: 30,000 sq. ft.

Shelter Cost: None—inherent in basic design

Protection Factor: 170

The Springfield Gas Light Company initiated construction on some new plant facilities which were to be completed during the summer of 1964. A partial basement would have been necessary for such items as record storage, telephone and electrical rooms, storage vaults, incinerator area, and an elevator machinery area. The company had used all of its available record storage space and was renting space in other facilities. The new plant was to provide for the present and future storage requirements. The architects persuaded the owners of the advisability and practicality of incorporating a full basement which would be usable as a shelter area as well as for the additional storage space. In this facility it was possible to incorporate shelter space without any appreciable added cost in the overall construction. The only change made from what would have been so-called normal construction, was to use 7 inch reinforced concrete instead of the normal 4 inches, but this was done to give greater protection to the record storage vault than to directly contribute to the fallout shelter construction. The building, as presently designed, calls for the addition of a future third floor which, when completed, will increase the fallout protection in the shelter area.

The record storage area is laid out so that the files are along the exterior wall with the center left open. The mass weight of the records would then also contribute to the protection, however, this was not considered in the protection factor calculations.

NEW PLANT FACILITIES
SPRINGFIELD GAS LIGHT CO.
MINSON & MILES INC.
ARCHITECTS · ENGINEERS

New England Telephone & Telegraph Office Building

Location: Framingham, Mass.
Owner: New England Telephone & Telegraph Company
Architect: Hoyle, Doran, and Berry,
Boston, Mass.
Structural and Shelter Analysis:
Nisso T. Aladjem, Lexington, Mass.

Total Cost: $3,150,000

Gross Area: 141,522 sq. ft.

Cost per sq. ft.: $22.26

Shelter Area: 15,000 sq. ft.

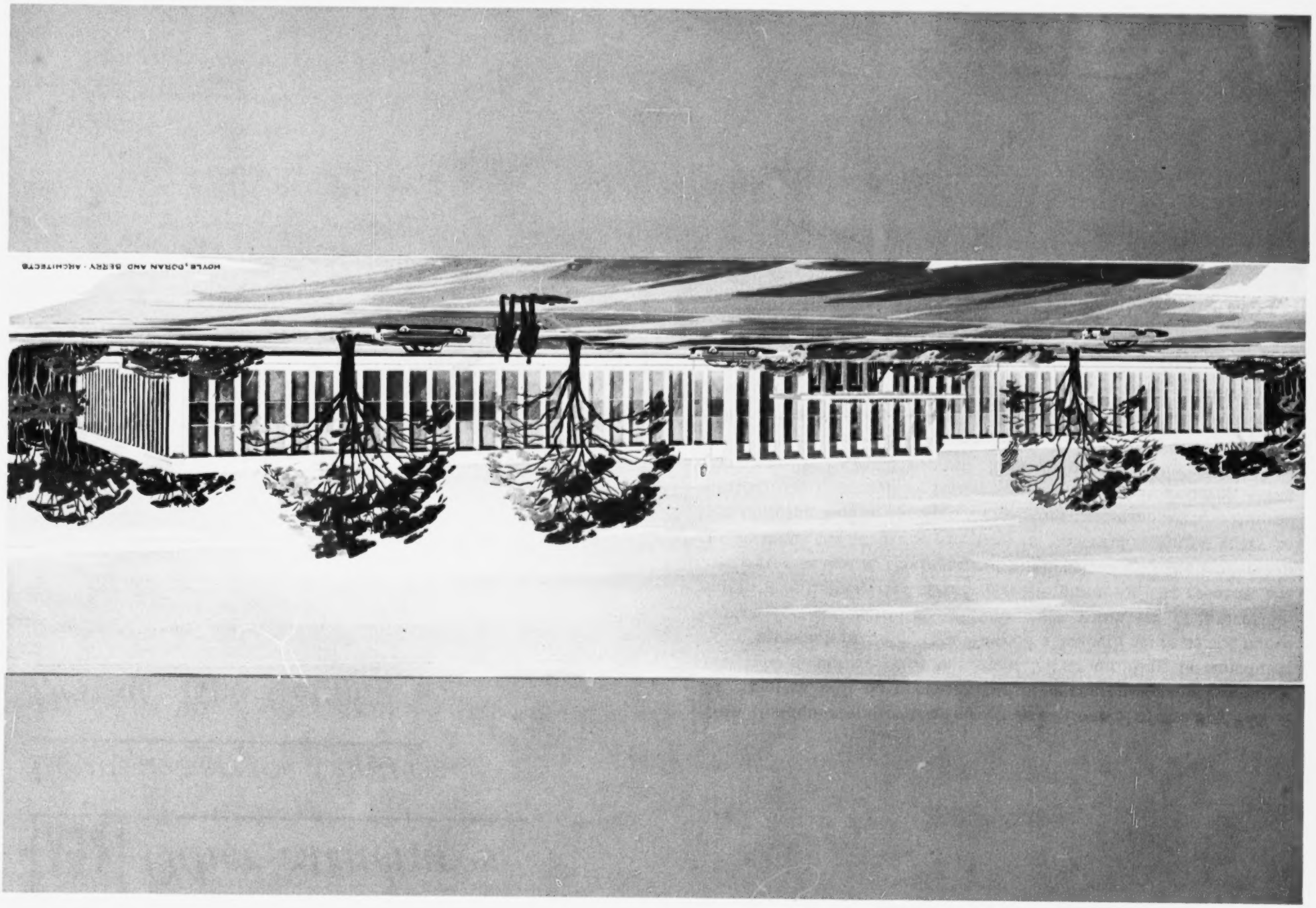
Shelter Cost:
General Construction: $23,000
Additional Equipment (mechanical, electrical, etc.): $2,000

Shelter General Construction Cost per sq. ft. of Gross Area: $0.16

The three-story concrete and steel building houses the New England Telephone & Telegraph Company State Area Headquarters. Most of the groundfloor (which is virtually windowless) is belowgrade. This floor contains conference rooms and instructor's room, library and stock rooms, mechanical equipment and storage room. The fallout shelter area is located in the ground floor. The exposed wall between the first and ground floors, abovegrade adjacent to the shelter area, is 18-inch concrete. The rest of the wall below the first floor is only 12 inches of concrete. Precast concrete window walls are utilized above the first floor. Overhead protection is obtained by using a 4-inch slab on fireproofed structural steel frame for the room. The second floor is cellular steel and 2¾-inch concrete fill on fireproofed structural steel frame. The first floor utilizes concrete joists and a 2¾-inch concrete fill. The area directly over the shelter has a total floor mass equal to 12 inches of concrete. Protection factor is greater than 100.

For ventilation, air enters the building through an areaway maze to a concrete plenum chamber located under the rear entrance platform. Plenum and areaway are separated by a throw-away type of filter bank. Air fans are connected to emergency diesel generator, capable of delivering 30-kw. Diesel oil storage is outside the building in a 1,000 gallon tank belowgrade.

Mechanical ventilation and emergency generators and storage tanks were included by the architect as part of the normal function of the structure and were not directly attributed to the shelter cost.


HOYLE, DORAN AND BERRY · ARCHITECTS

Other Structures

Council Service Center

Detroit Area Council

Location: Detroit, Mich.
Owner: Boy Scouts of America
Architect-Engineer: Eberle M. Smith Associates
Detroit, Mich.

Project Cost: $410,095

Gross Area: 18,481 sq. ft.

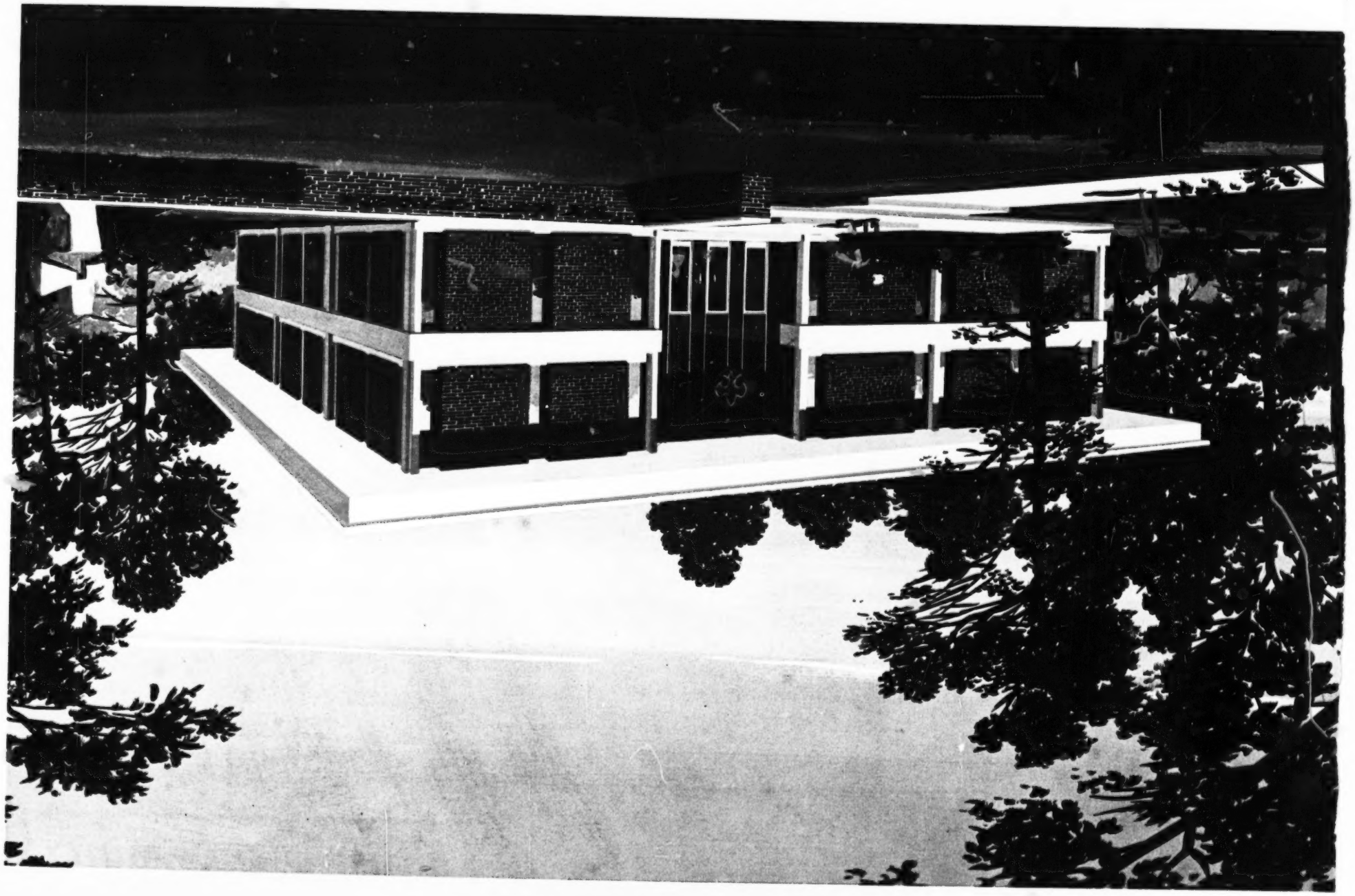
Cost per sq. ft.: $22.10

Shelter Area: 2,400 sq. ft.

Shelter Cost: None—inherent in basic design

Protection Factor: 135

New Headquarters for the Detroit Area Council of the Boy Scouts of America will be provided for in a contemporary two-story concrete structure with basement. The building is scheduled for completion in 1965. The Council office will serve as the nerve center for the activities of this vast volunteer organization. From it will emanate the policies, the planning, the records, the restricted insignia, the technical publications and the leadership to promote the scouting program in this area. Major entry to the building will be through a two-story reception area. Housed on the first floor will be conference rooms and in general, areas which are to be readily available to the public. The second floor primarily contains office space: executive, field service, relationship service. Service facilities for the most part are located in the basement. The shelter area is also located in the basement and is inherent in the basic design.



Other Structures

Bohemia Toll Terminal Building

Location: 610 Johnson Avenue, Bohemia Islip, Long Island, N.Y.
Owner: New York Telephone Company, Long Island Area
Architect: Paul L. Wood & Associates, New York, N.Y.
Structural: Lambert & Dell'Abate, New York, N.Y.
Mechanical: Sidney W. Barbanel, Long Island, N.Y.
Shelter Analyst: Ralph Dell'Abate, Brooklyn, N.Y.

Project Cost: About $425,000 exclusive of professional fees, land, or landscaping

Gross Area: 12,813 sq. ft.

Shelter Area: 11,691 sq. ft.

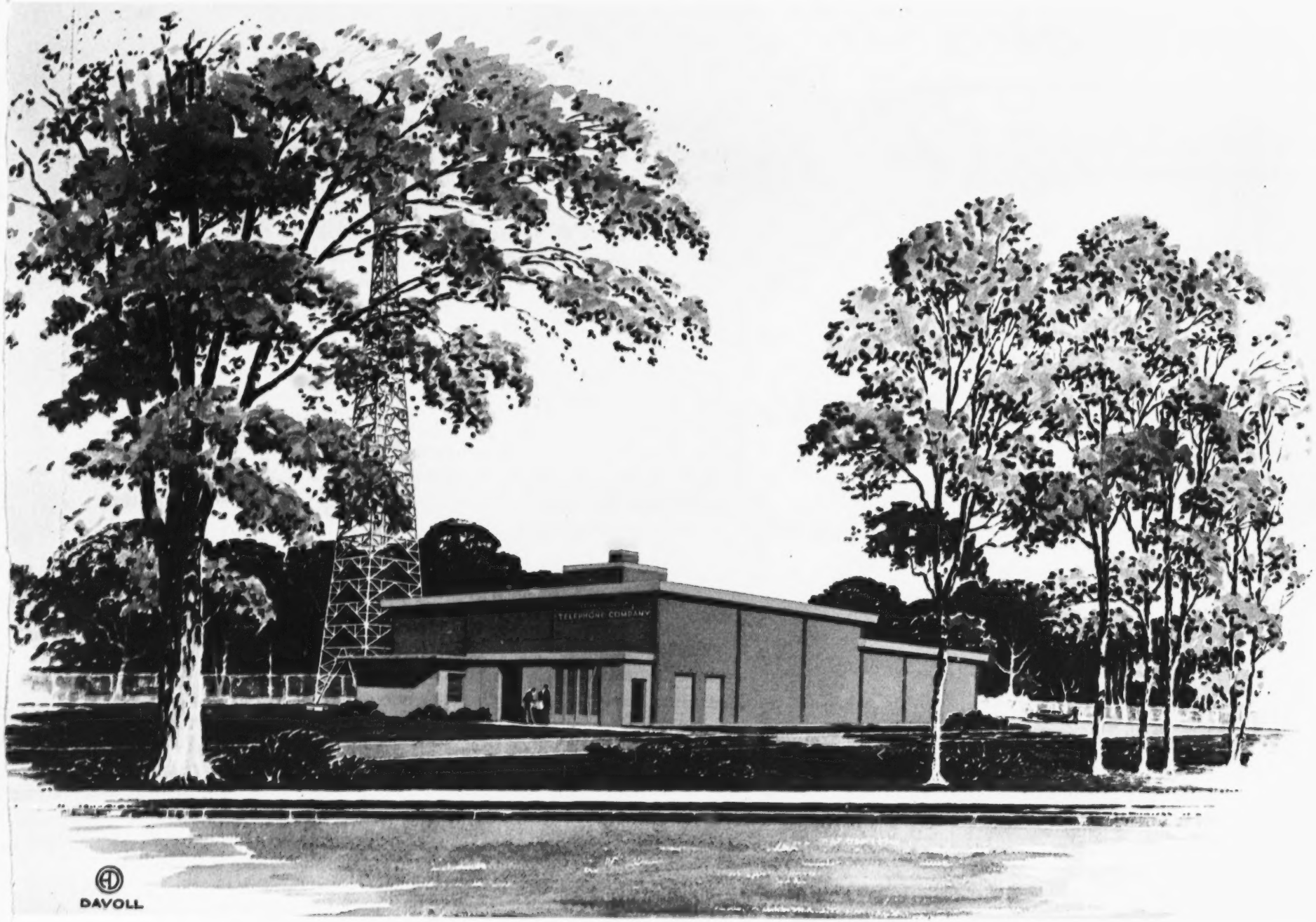
Shelter Cost: Unknown

Protection Factor: 100

A part of the building was completed and occupied in June 1962. The building houses radio relay and other special equipment which is related to the Federal Aviation Agency's control of aircraft movements along the eastern seaboard and commercial air-to-ground communications service for the major airlines. Because the facilities in the building must continue to be available immediately following a nuclear attack, the architects were directed by the owners to provide fallout protection.

In 1964 an addition was added and the original building was encased with brick and concrete, providing a wall mass equivalent to 200 psf and a roof mass of 150 psf.

The building is to be almost completely occupied with equipment, much of which has a high operating heat release. To cope with the heat release, the building is fully air conditioned. Emergency power, in the form of two 225-kw diesel engine alternators, is available to operate the equipment if normal power source fails.



DAVOLL

Other Structures

McLean Bible Church

Location: McLean, Va.
Owner: McLean Bible Church
Architect: Russell W. Jenkins, Jr., AIA, McLean, Va.

Project Cost: $217,344 (Low bid)

Gross Area: 14,260 sq. ft.

Cost per sq. ft.: $15.24

Shelter Area: 3,000 sq. ft.

Shelter Cost: $900 (see text)

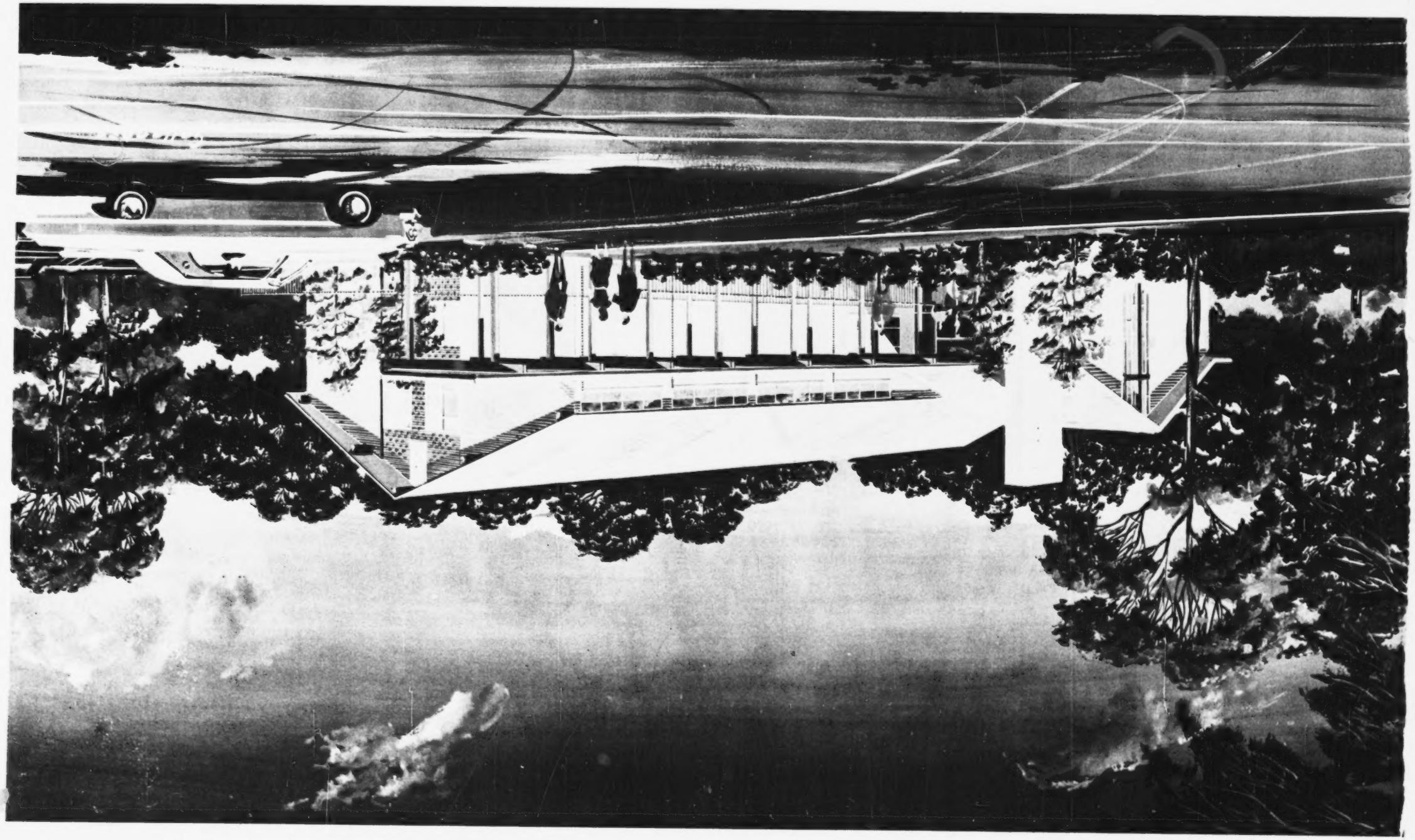
Shelter Cost per sq. ft. of Gross Area: $0.06

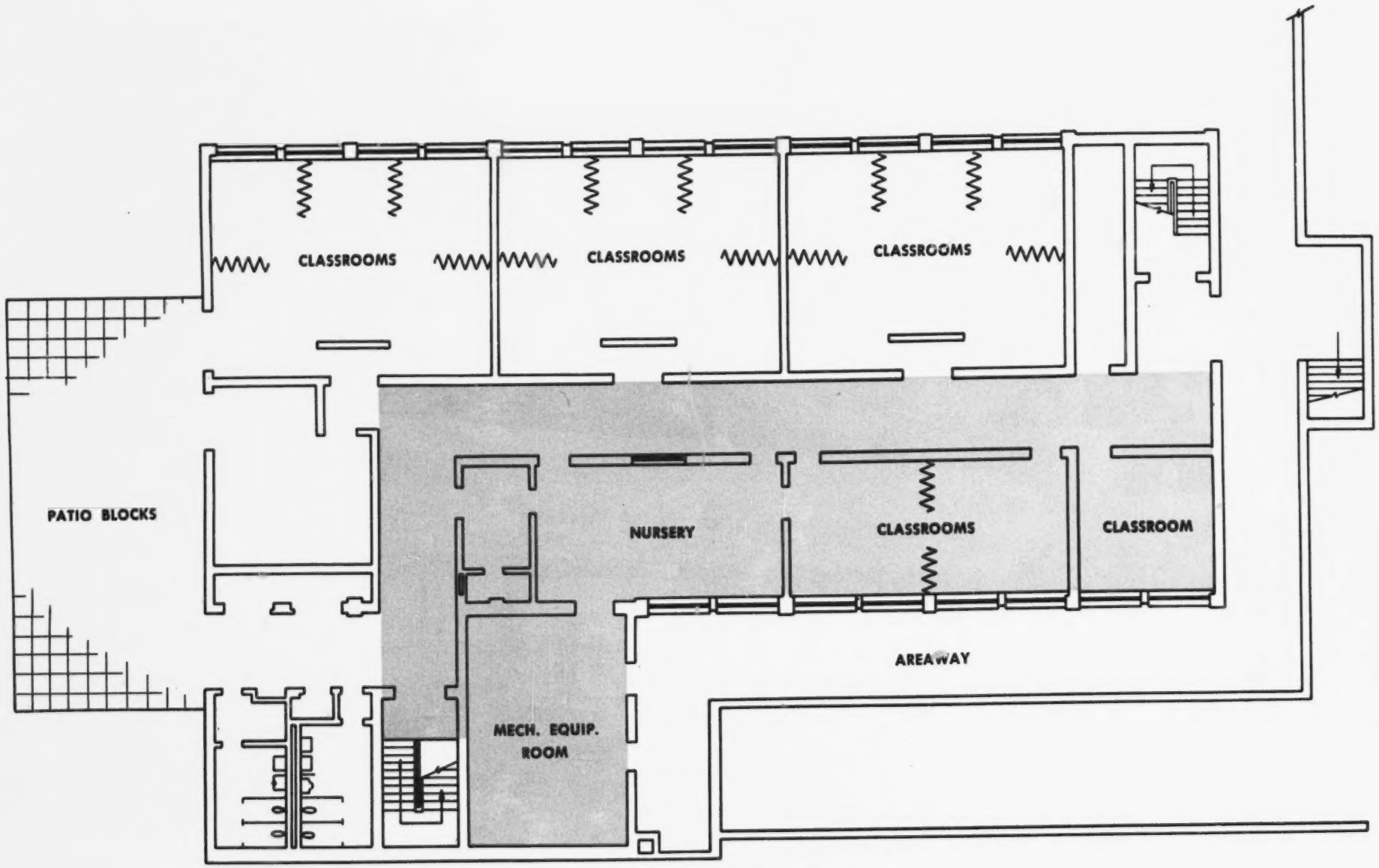
The architect of this project was requested to investigate the feasibility of including fallout protection for not less than 300 persons in the first increment of a phased church construction project. It was determined that it would be most economical to include the protection features in the original design reserving the option of eliminating some of these features by deductive bid items in the specifications if the project cost exceeded the budget allocation.

The three elements which constituted items required solely for fallout protection were: (1) increasing first floor slab topping on the double T-beam from 2 inches to 6 inches in thickness; (2) increasing concrete block size from 8 inches to 12 inches on exterior walls; and (3) filling cores of all hollow block walls around the shelter area with sand.

The contractor submitting the lowest bid would allow only $900 decrease in his total bid price for these shelter features. The obvious advantage of this method of providing shelter in the original basic design is that the shelter cost to the client is even less than an alternate set of construction drawings, proving that in many cases integrated shelter need not be expensive when included early in the planning stages as a design consideration.

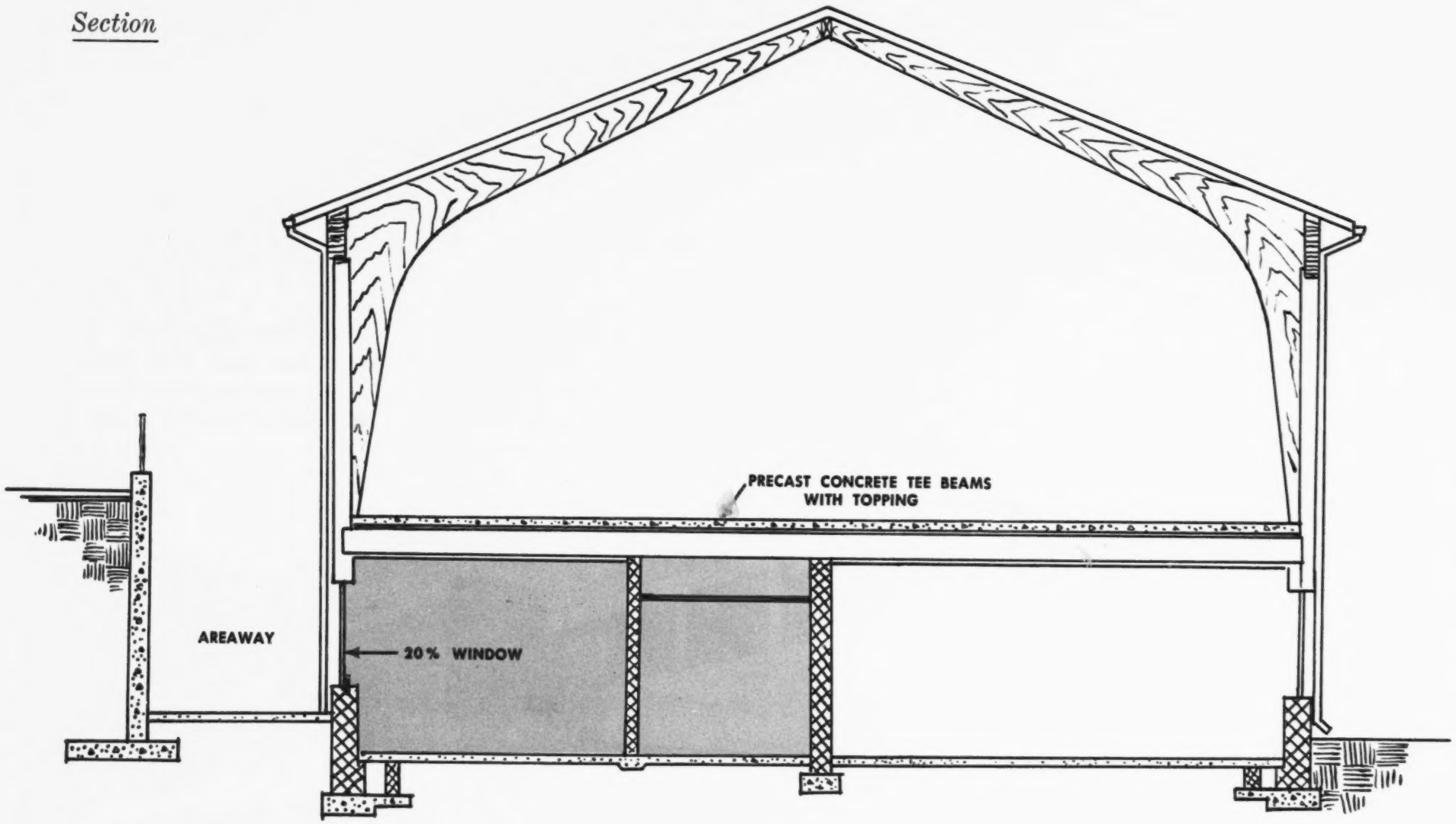
The shelter area is located in the corridor and Sunday School classrooms of the first floor (3,000 sq. ft.).




CLASSROOMS
CLASSROOMS
CLASSROOMS
PATIO BLOCKS
NURSERY
CLASSROOMS
CLASSROOM
AREAWAY
MECH. EQUIP. ROOM

Floor Plan

Section



Other Structures

Central National Insurance Group—Garage

Location: 700 South 72d Street,
Omaha, Nebr.
Owner: Central National Insurance Group
Architect-Engineer: Leo A. Daly Company,
Omaha, Nebr.
Shelter Analyst:
William Alsmeyer,
Omaha, Nebr.

Project Cost: $120,000

Building Area: 6,200 sq. ft.

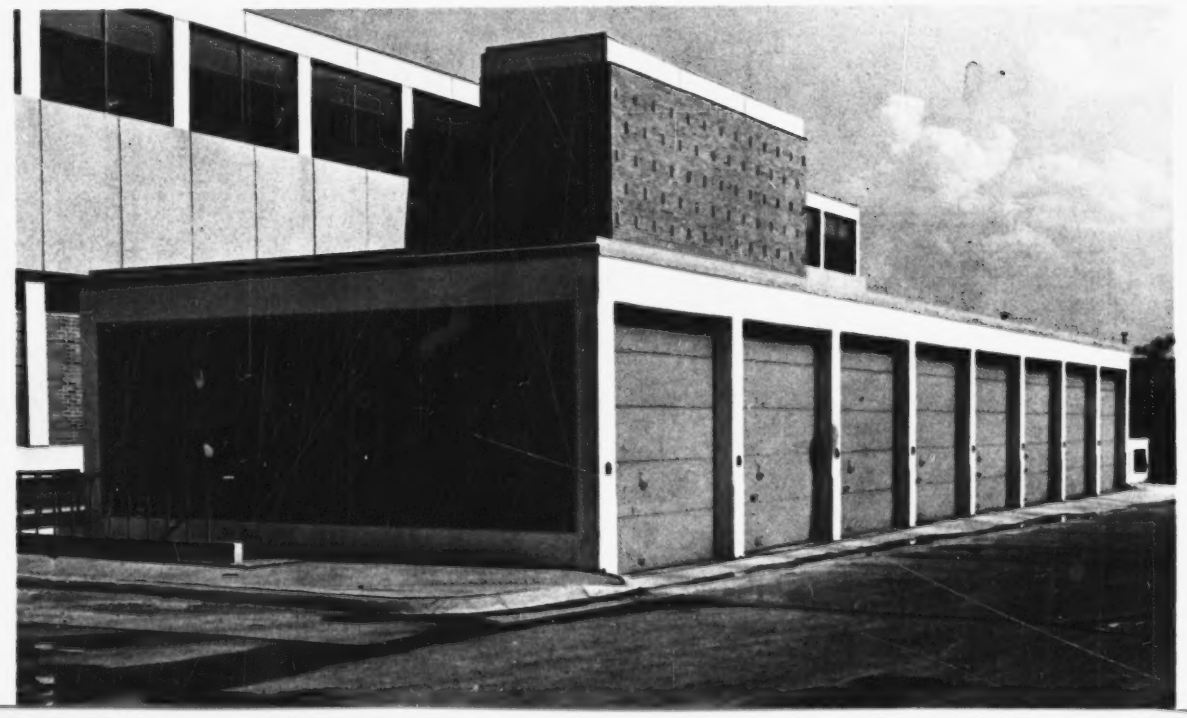
Shelter Area: 2,100 sq. ft.

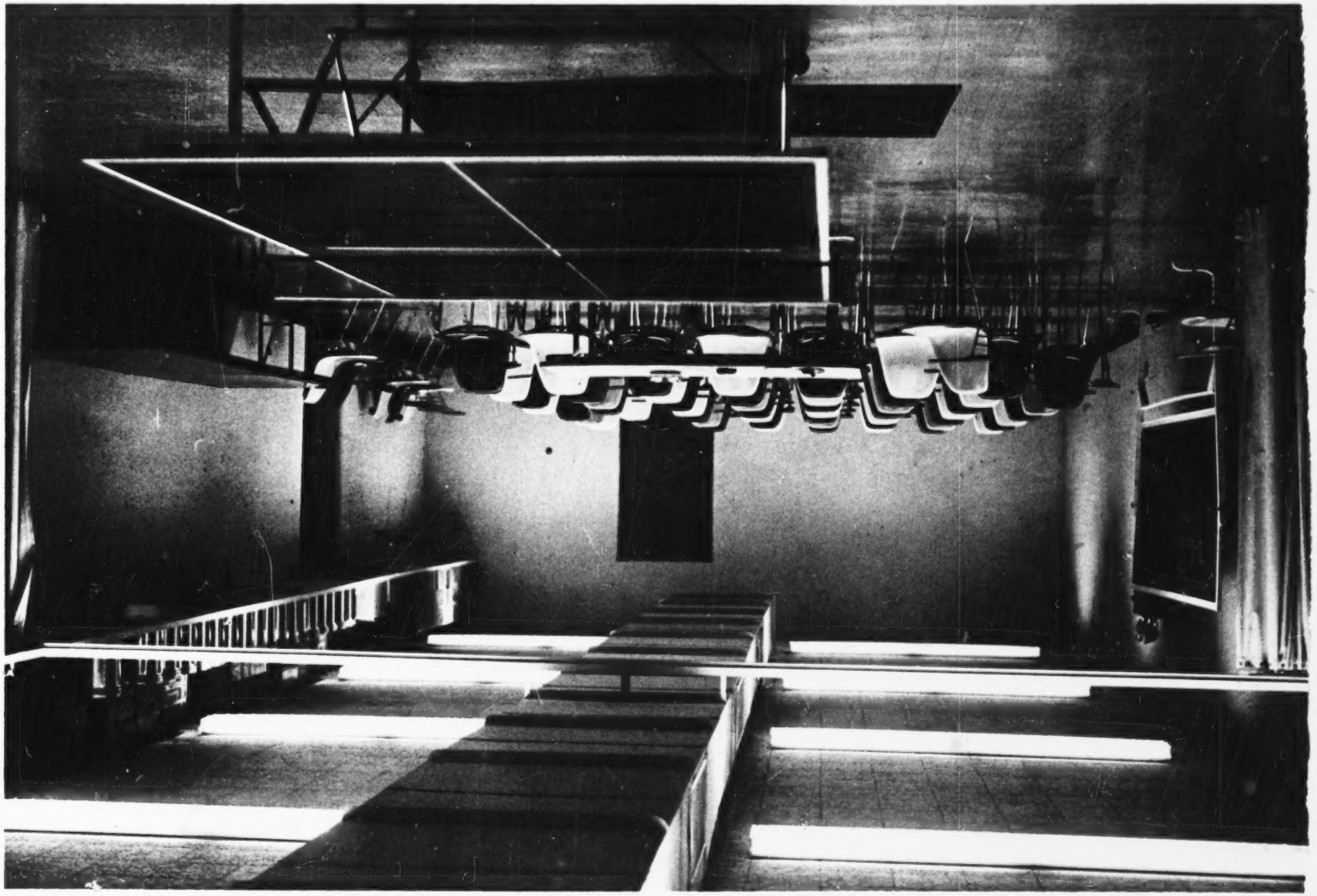
Shelter Cost: Unknown

Protection Factor: 1,000

The structure was built as part of an addition to the executive building which was incorporated in a complex constructed for the Central National Insurance Group.

The structure is a one-story building with a basement. The upper story is used as a garage and storage area. The basement is used as a meeting room and also provides the shelter space. An 18-inch concrete slab serves as the room of the shelter and as the floor of the garage and storage area.





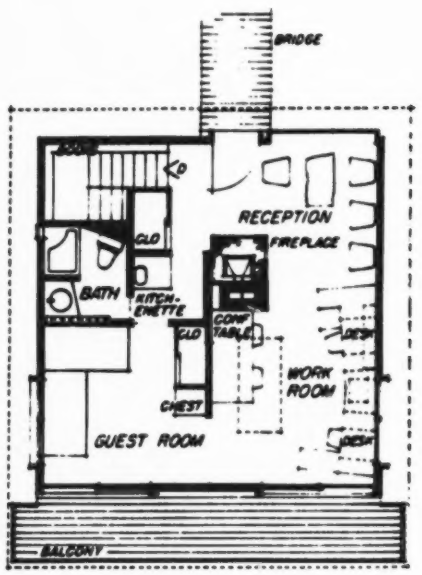
Other Structures

Author's Studio and Workshop

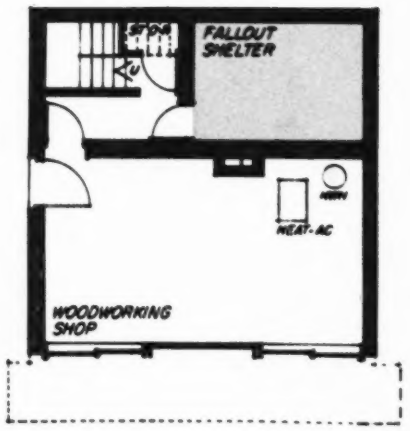
Location: 1611 Turkey Run Road,
McLean, Va.
Owner: Dr. Arthur and Evelyn Metzger
Architect: William C. Suite and John F. Dirks, Jr.
Washington, D.C.

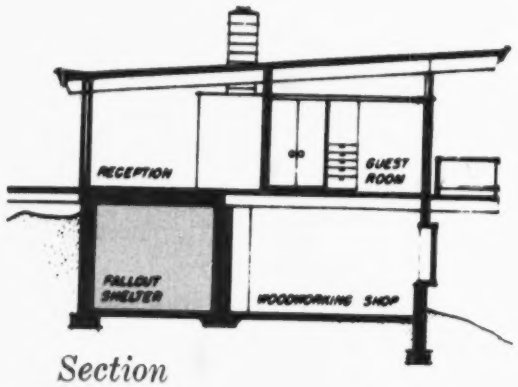
This structure serves as a combination author's studio, guest house and workshop. The structure was built in 1963. Shelter is located on the ground floor with protection provided by a 12-inch reinforced concrete ceiling slab and walls of 12-inch and 16-inch solid concrete block.

Upper Level



Lower Level





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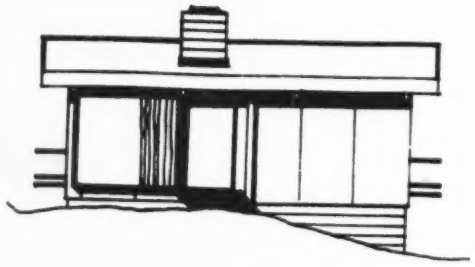
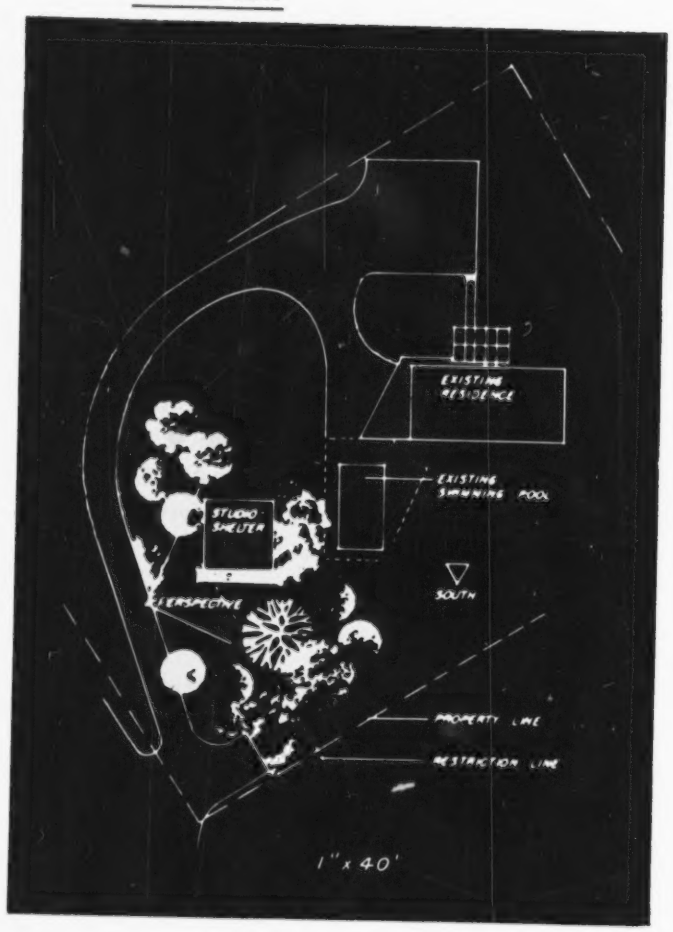
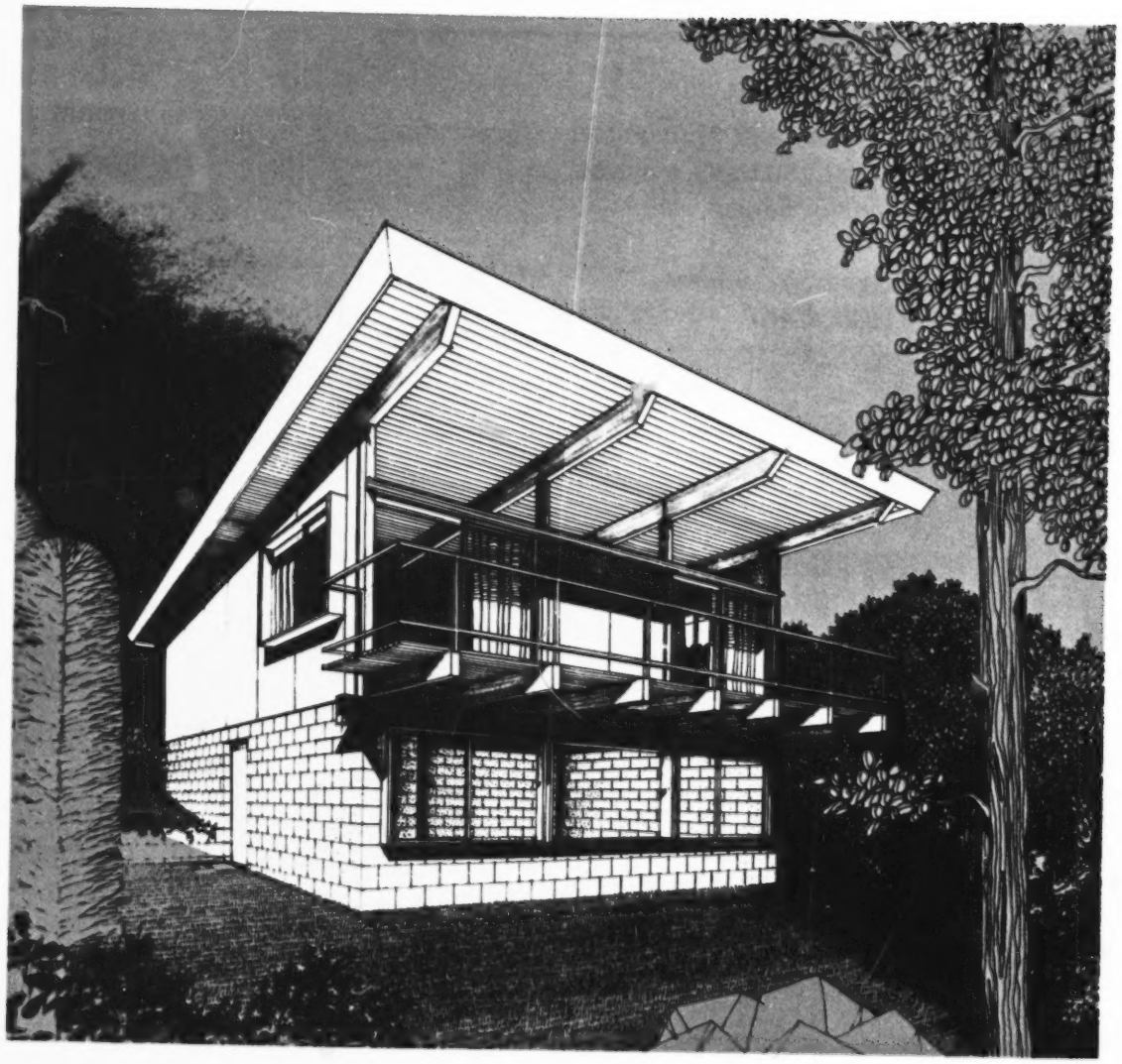


Elevation at Entrance

Site Plan





Other Structures

City National Bank Building

Location: Los Angeles, Calif.
Owners: Buckeye Realty and Management Corporation,
Buckeye Construction Company,
Wolper Productions

Architect: Victor Gruen Associates,
Beverly Hills, Calif.
New York, N.Y.

Project Cost: In excess of $4 million

Gross Area: 210,000 sq. ft.

Cost per sq. ft.: over $19.00

Shelter Area: 47,770 sq. ft.

Shelter Cost: $20,000*

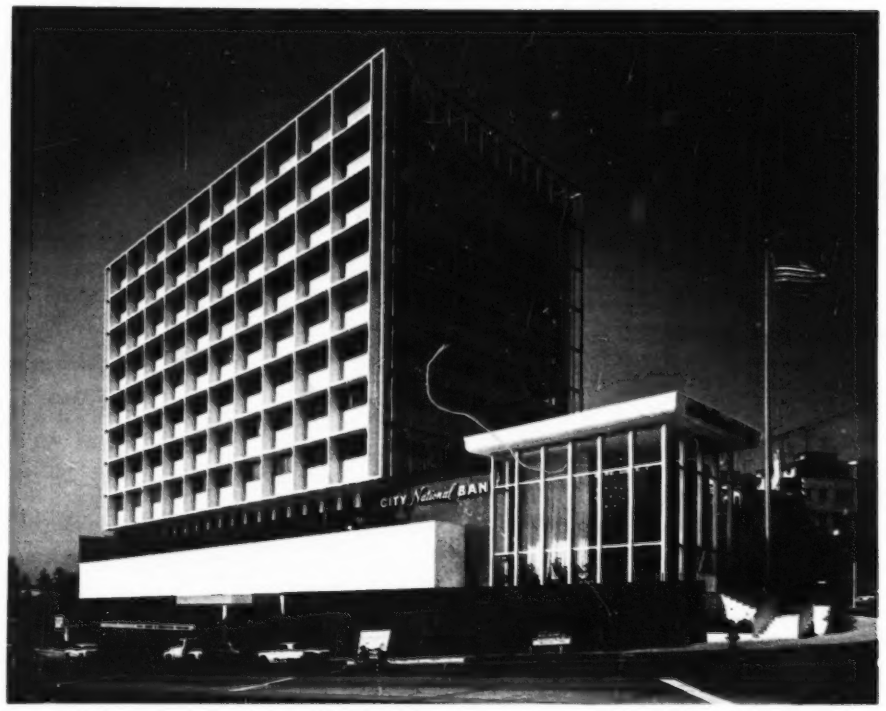
*The cost shown includes equipment only. There was no cost for providing structural shielding.

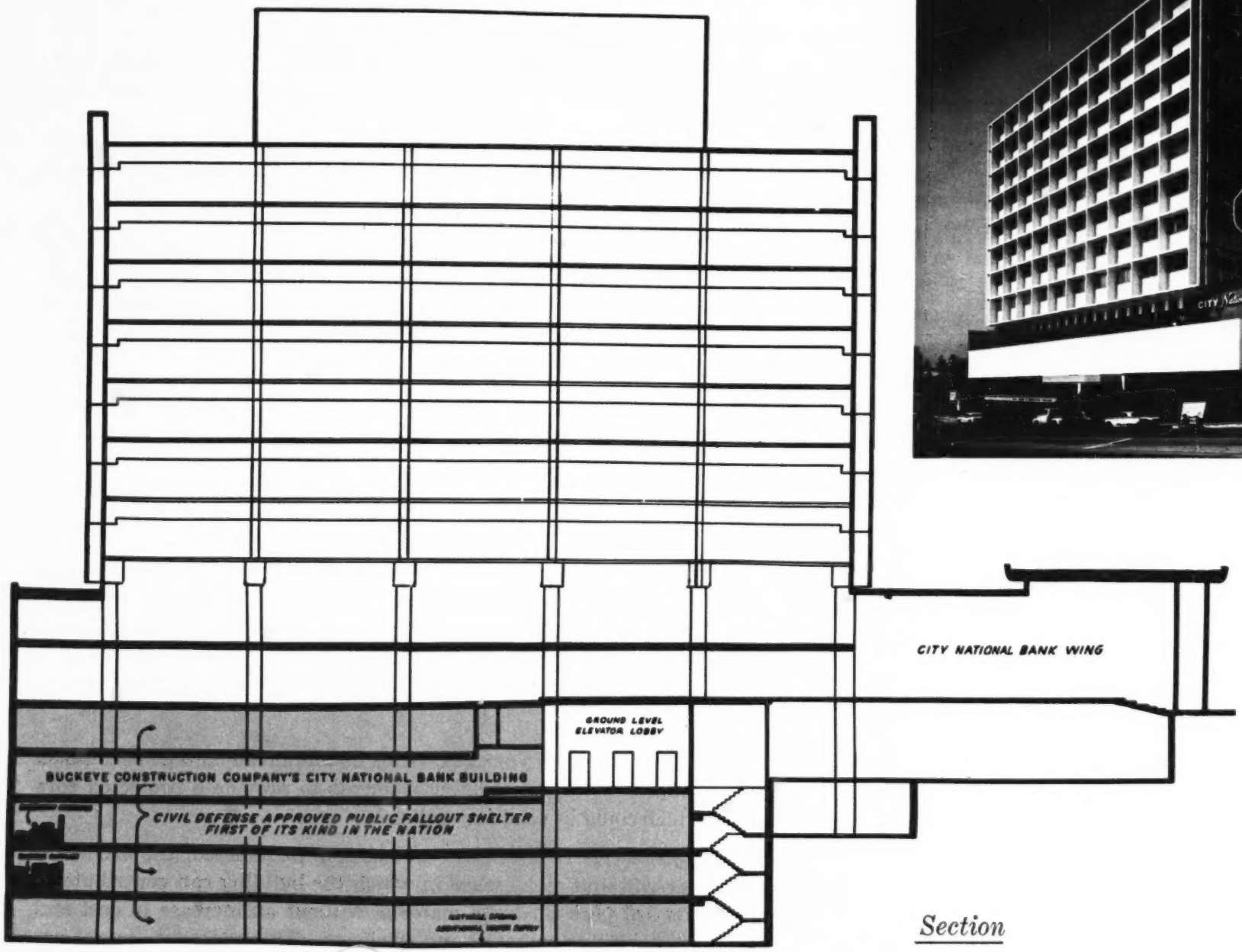
The shelter in the City National Bank Building was the first of several incorporated into the Buckeye organization office buildings. The owners initiated the program on their own, and directed the research and planning to incorporate the shelter at the beginning of the project design phase.

The shelter can accommodate 4,777 persons in the lower levels of the parking garage. This provides protection for the buildings' daytime population of 1,000 in addition to 3,777 persons from the surrounding residential neighborhood.

Survival supplies that were purchased by the building owners are stored in spaces that were specifically designed for this purpose. These supplies include multi-purpose food, water from a natural spring in the basement, medical supplies, cots and blankets, sanitary supplies, fuel for emergency generators, radio receivers and radiation instruments.

Due to the inherent shielding of the belowground portion of the building no additional structural costs were incurred in constructing the shelter areas. The cost of mechanical and electrical support systems such as a 40-kw emergency generator to provide emergency power for lighting, ventilation and water pumps amounted to $20,000.


CITY National BAN


CITY NATIONAL BANK WING
GROUND LEVEL
ELEVATOR LOBBY
BUCKEYE CONSTRUCTION COMPANY'S CITY NATIONAL BANK BUILDING
CIVIL DEFENSE APPROVED PUBLIC FALLOUT SHELTER
FIRST OF ITS KIND IN THE NATION

Section

"Slanting" in Design & Construction

Creation of Fallout Shelter Through Slanting & Cost Reduction Techniques

Slanting is defined as the incorporation, without extra cost or reduction in efficiency of certain architectural and engineering features into all new structures, to protect personnel from fallout gamma radiation in event of an emergency. The slanting features may provide immediate improvement or may be of such nature as to facilitate later conversion of the structure for protective purposes. Thus, slanting adds the protective function to the other elements normally considered in the design of structures.

Every building is a natural shield against fallout radiation. Some buildings, however, are better than others. In the Fallout Shelter Survey, over 77 million shelter spaces were found with PF 100 or more and an additional 44 million spaces with PF 40–99. Many other buildings would have provided reasonably adequate protection, but they had weak points which nullified otherwise good protection. If these weak points could have been detected by someone knowledgeable in radiation shielding analysis during the initial design phase of the project, "no-cost" design changes could have been incorporated to maximize the protection without exceeding budget limitations.

Examples of items to be considered in slanting are:

a. Location and quantity of window areas.—Could window areas be reduced or could sills be raised to reduce exposure to radiation?

b. Site conditions.—Is the structure located so the maximum advantage is taken of mutual shielding from adjacent structures? Has consideration been given to use of retaining walls, planters, overhangs or grading of slopes away from the structure to minimize the effect of radiation from fallout on the ground?

c. Basement.—Is it possible to depress the ground floor partially or completely belowgrade to reduce the effect of radiation from fallout on the ground?

d. Entrances and Exits.—Have these been located to maximize the protection by baffles or do they permit direct entry of the ground radiation? Can stairwells be positioned so that they provide additional shielding at the ends of corridors and hallways? (See figs. 1 and 2.)

e. Partitions.—Have interior partitions been placed to block radiation?

f. Have dense, solid walls been used advantageously? Have hollow walls been filled with low cost materials where feasible? (See fig. 3.)

g. Floors and Roofs.—Has a comparison been made of various systems such as concrete slabs on precast T-beams or bar joists, composite floor systems such as tile or terrazzo on concrete, or two-way slab design versus pan-joist construction? Cost differentials may be negligible but one system may provide significant additional shielding. (See figs. 4 and 5.)

h. Architectural Arrangement.—Has maximum advantage been taken in arrangement of the building elements to provide a protected core area which could be used for shelter?

If the protective requirements are clearly understood, the architect-engineer will find many ways in which the building can contribute to the safety of personnel and material without an increase in cost and without sacrificing esthetics and efficiency. This procedure might not always provide shelter spaces with PF 100, but certainly will provide some protection at no cost.

Enhancing Shelter Characteristics at Minimum Cost

In addition to using the slanting procedure noted above, there are other low cost techniques in handling shielding and geometry factors which would enhance inherent shelter characteristics to meet OCD standards and criteria.

Examples of some of these low-cost techniques are:

a. Wall Construction.—Has consideration been given to utilizing reinforced concrete or concrete block construction in lieu of lightweight aggregate block or other lightweight wall construction? Have low cost opportunities been exploited such as use of hollow tile or concrete block with sand or gravel fill to provide additional mass in interior and exterior walls? (See fig. 3.)

b. Esthetics.—Has consideration been given to providing masonry screen walls, or planter boxes for esthetic value as well as increasing the mass for shielding purposes? (See fig. 6.)

c. Floor and Roof Construction.—The addition of a few inches of concrete topping to a precast concrete tee roof or floor slab system will do much to enhance the protection afforded occupants.

d. Site and Earthwork.—By judicious site work and location of earth berms, it is possible to improve the shelter provided in a structure.

Cost Reduction Techniques

A number of techniques have been devised which should reduce the cost of obtaining shelter spaces. They are as follows:

a. Ventilation.—The requirements of ventilation of buildings incorporating shelter should be based on normal usage of the facility. Where increased ventilation is necessitated to utilize the full capacity of the shelter area and make it habitable, consideration should be given to the use of packaged ventilation kits now being developed by the Office of Civil Defense in lieu of increasing the capacity of the permanent ventilation system.

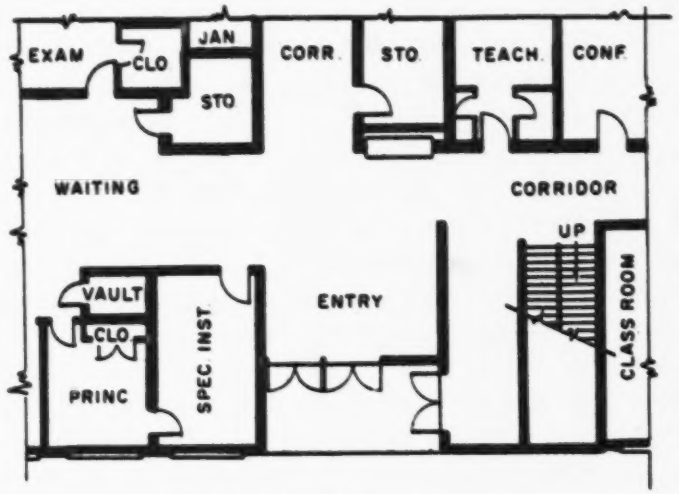
b. Trapped Water and Sanitary Facilities.—The requirements for a supply of potable water necessary for survival constitutes one of the fundamental problems in achieving shelter habitability. A minimum of 3½ gallons should be available for each shelter space stocked. The Federal Government provides austere emergency rations and supplies to those spaces designated as public fallout shelters. In addition to these supplies, potable water may be furnished to the shelter from a variety of sources. These include entrapped water in building systems, wells, tanks, steel drums with plastic liners as furnished by OCD, or a combination of any of these sources. In stocking public fallout shelters, a determination will be made as to the most effective and desirable means of assuring the availability of the required water while minimizing cost and storage requirements.

The disposal of human waste in the shelter may be accomplished by a variety of methods including use of the existing sewerage systems, manholes providing access to sanitary or storm sewers, diversion of systems containing nonpotable water for flushing purposes and the use of the OCD furnished drums as chemical toilets. Where the water supply is furnished by means other than the OCD water storage container, the sanitation requirement may be met by furnishing a smaller number of drums than would be normally provided for water storage.

c. Food.—Public fallout shelters qualifying under the Federal Program are provisioned with OCD packaged food supplies. The amount of the standard ration to be placed in the shelter may be reduced if the equivalent food is available and certain other requirements pertaining to perishability and availability are met.

OCD Professional Development Program

The Office of Civil Defense sponsors a number of tuition free professional development courses at schools and universities throughout the country to acquaint architects and engineers with the techniques for the design and evaluation of fallout shelter. Architects and engineers interested in participating in these courses, should contact their local, State, or Regional Civil Defense Office or write to the Architectural and Engineering Services Division, OCD, Washington, D.C., 20310 for further details.



Unbaffled Entrance

Baffled Entrance

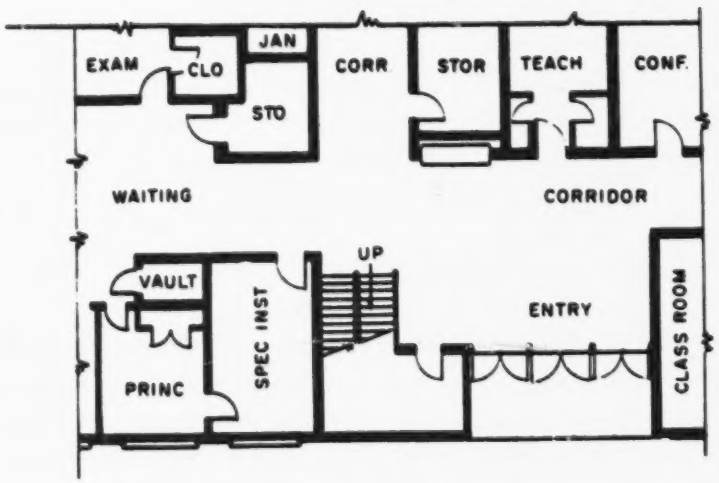
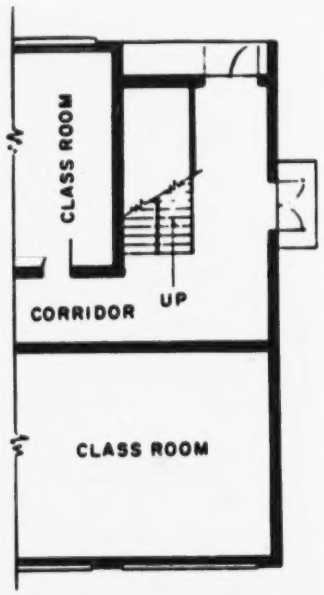
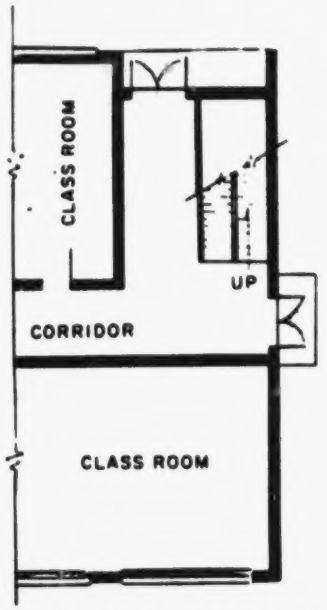


Figure 1



Baffled Entrance



Unbaffled Entrance

Figure 2

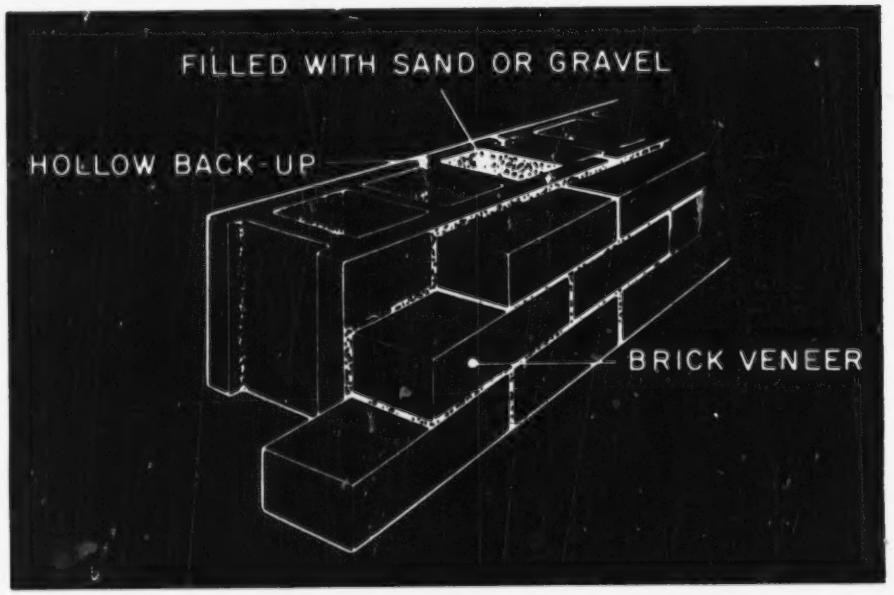
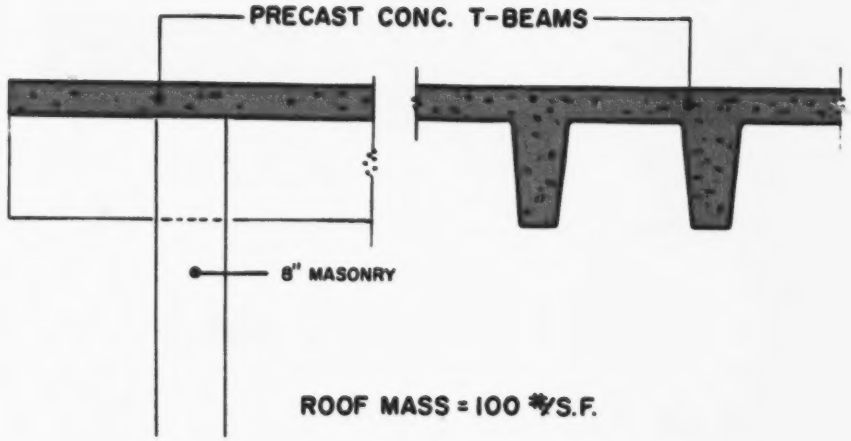
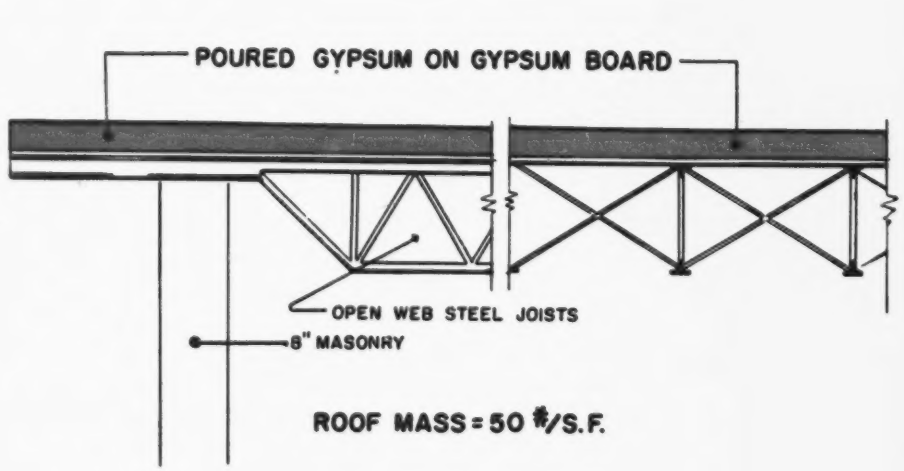


Figure 3

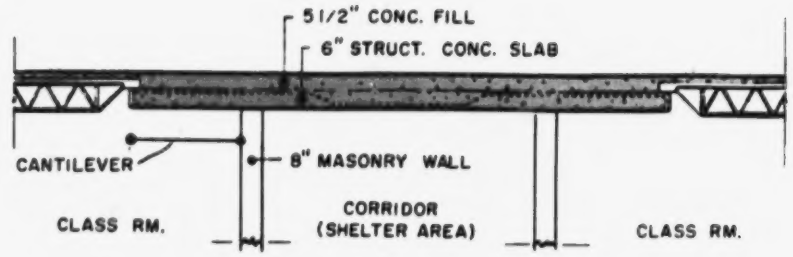


ROOF MASS = 100 #/S.F.

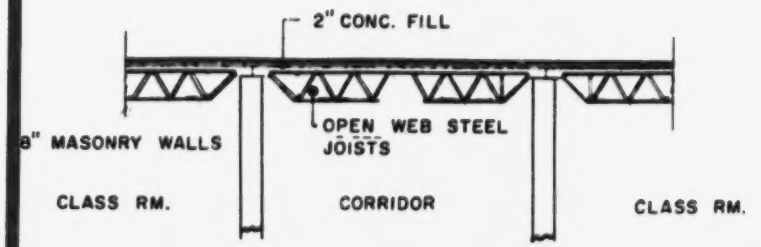


ROOF MASS = 50 #/S.F.

Figure 4

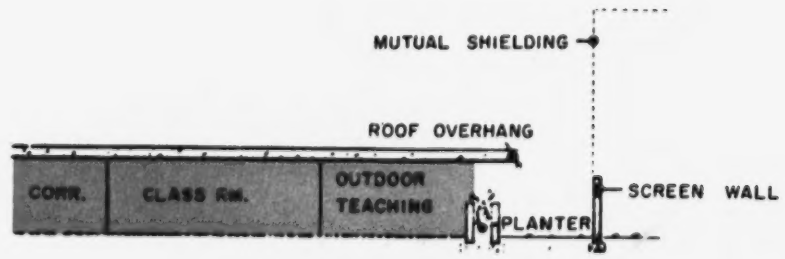


ROOF MASS = 150 #/S.F.



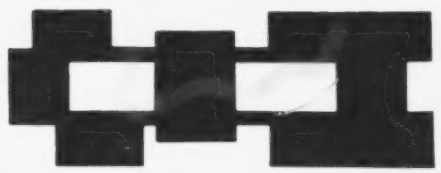
ROOF MASS - 40 #/S.F.

Figure 5



SHIELDING TECHNIQUES

Figure 6

SCHOOL	A  CONVENTIONAL	B SLANTED	C PROTECTED
COST	$500,000	$500,000	$515,000 ±
PF	250 Spaces @ PF 10 250 Spaces @ PF 25	325 Spaces @ PF 40 250 Spaces @ PF 20	625 Spaces @ PF 100
CONSTRUCTION	Large Window Area Hollow Block Walls Entrances Directly Off Corridors Panel Walls Lightweight Partitions Lightweight Roof Construction	Increase Sill Height Fill Hollow Blocks w/Sand Offset Entrances Stagger Doors & Windows Masonry Partitions Precast Roofs All Slanting Techniques	Screen Walls Roof Fill Planter Boxes Roof Overhangs Increase Wall Mass Depress Building Shields for Openings

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